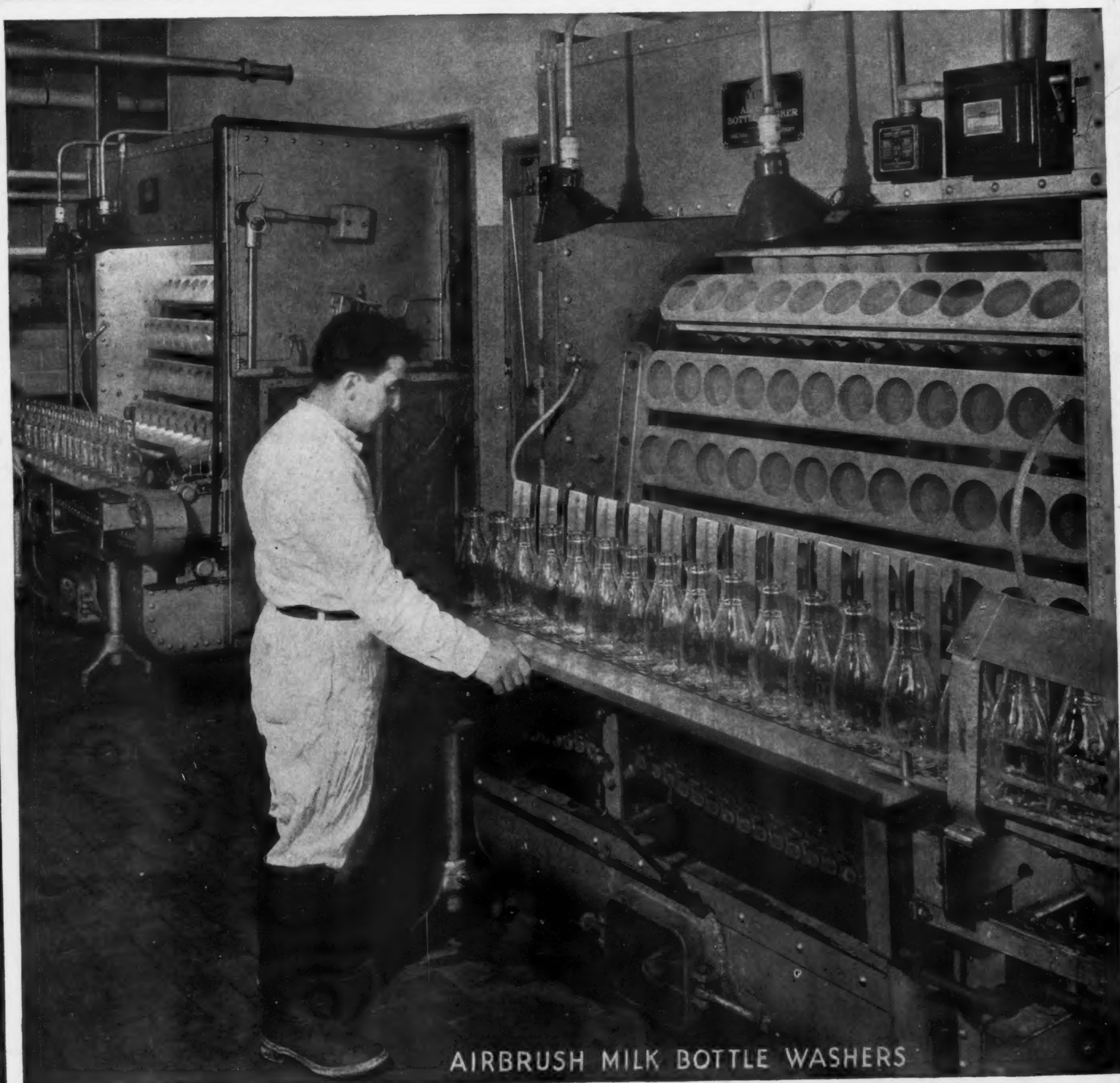
Compressed Air Magazine

Vol. 39, No. 6 London - New York - Paris June, 1934



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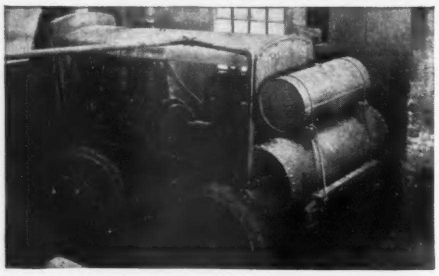

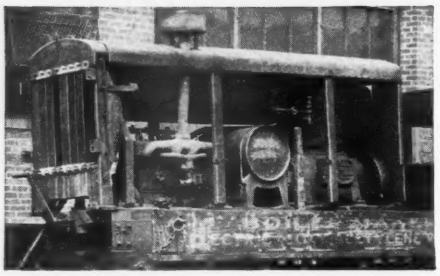

Illustrations above show the nine - and fourteen-year-old portable compressors.

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Office of HEIPERSHAUSEN BROS., INC.
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STEAM AND HOT WATER HEATING CONTRACTORS
43 TO 53 TOMPKINS STREET
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New York, January 15, 1934

Ingersoll-Rand Company
11 Broadway
New York, N.Y.

Gentlemen:

We are purchasing from you two new 250 cu.ft. Two-Stage, Air-Cooled compressors which are to take the place of two of your old machines that have been very faithful.

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The other machine is a 9x8 Imperial Type 20, purchased in 1925. It has given us similar service and efficiency. Therefore, we feel that we can safely purchase and recommend your compressors for work anywhere at any time.

In the fourteen years' service the 8x8 has been overhauled twice. The only parts required were a set of piston pin bushings for the compressor end and some new rings, bearings, and governor parts for the motor end. The 9x8 has been overhauled but once and nothing required renewing in the compressor end at all.

We also have had a 6x6 in service since 1924 which has given wonderful service and which also helps to make us a satisfied user of Ingersoll-Rand products.

Yours truly,

HEIPERSHAUSEN BROS. INC.

Arthur P. Heipershausen

Secretary

Two new 250-foot Two-Stage Air-Cooled Compressors that replaced the old machines.

Ingersoll-Rand

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A Monthly Publication Devoted to the Many Fields of Endeavor in which Compressed Air Serves Useful Purposes

FOUNDED 1896

Business, Editorial and Publication Offices
PHILLIPSBURG, N. J.

Advertising Office
11 Broadway
NEW YORK CITY

Compressed Air Magazine

JUNE  1934

Volume 39 ■ ■ Number 6

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Annual subscription rate: Domestic, $3.00; Foreign, $3.50; single copies, 35 cents.

Manuscripts intended for editorial consideration should be accompanied by return postage.

« « « COMPRESSED AIR MAGAZINE is on file in many public libraries and is indexed in INDUSTRIAL ARTS INDEX » » » »

A New Milk Plant in New York

C. H. VIVIAN

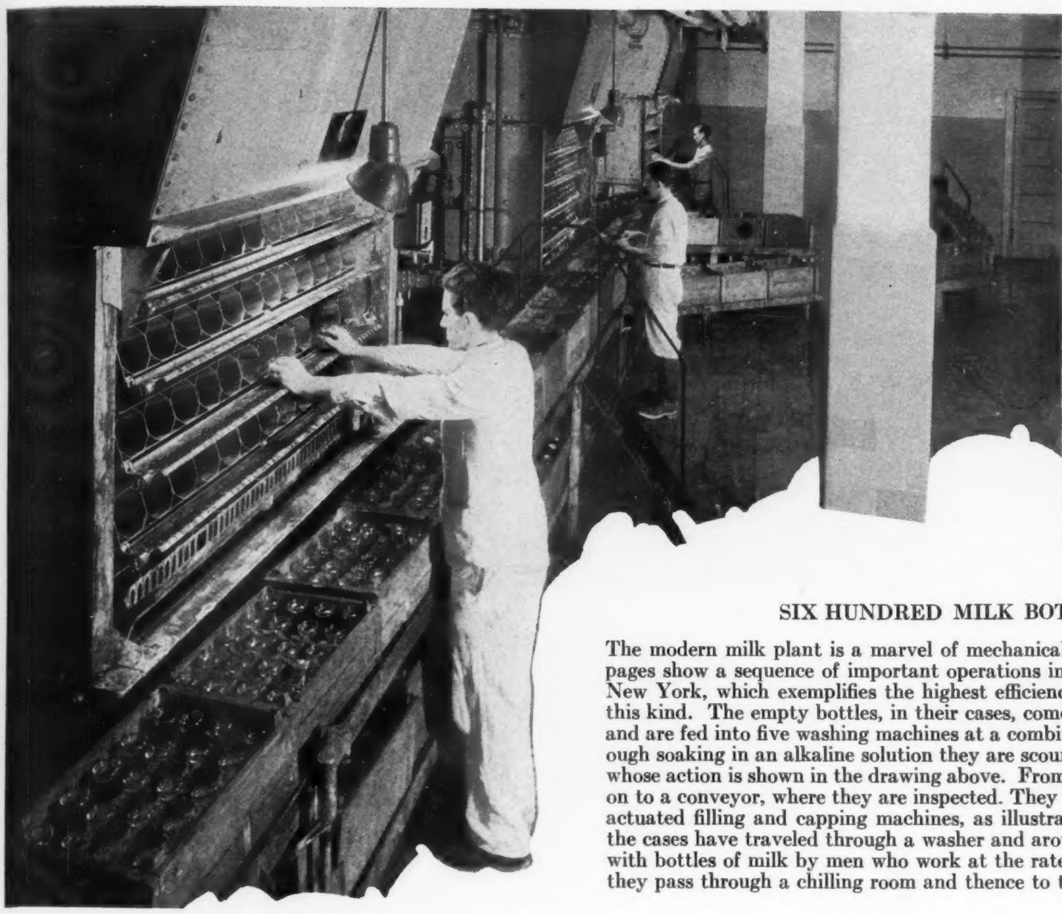
THE business of supplying milk to New York City is chiefly in the hands of a few large concerns. This arrangement is inevitable under the conditions that prevail. Within the city proper, cows are so scarce that many children of school age have never seen one. Consequently, the milk supply must come wholly from outside, and the amount required is so great that much of it must be secured from areas from 100 to 400 miles away. The gathering, transportation, processing, and distribution problems thus entailed are in the aggregate colossal. Something akin to chaos would result were the 6,000,000 inhabitants of the Metropolis forced to depend entirely upon a multiplicity of small merchants for such a vital commodity. The supply would never be sure, the multiplication of plants, equipment, and personnels would increase costs to the consumer inordinately, and the scattered activities would complicate the vital function of the health department in maintaining strict surveillance over them. Manifestly, economy, efficiency, and protection of the public call for facilities, resources, and capital on a scale which can be had only through huge organizations.

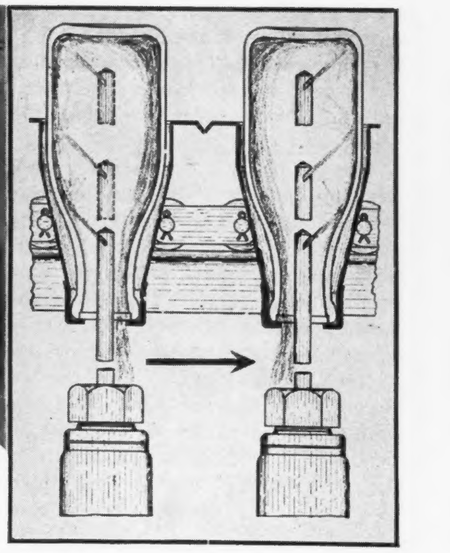
One of the important suppliers of milk to New York City is the Dairymen's League Co-operative Association, Inc. As the name implies, it is a mutual organization. It is owned by the 48,000 farmers that supply it with milk. Collectively, they own 700,000 cows distributed throughout New York, Pennsylvania, New Jersey, Connecticut, and Vermont, a territory constituting what is known as the New York milkshed. They supply various cities other than New York with milk and cream, butter, and cheese, and other accessory products are even more widely merchandised.

It is said that the idea which has grown into a concern producing more than 1,500,000 tons of milk annually was conceived in 1905 by a farmer in Orange County, New York, who visioned the advantages of the dairymen of the neighborhood banding together to sell their milk. Certain it is that it grew to its present proportions largely because it insured its members a steady market for their milk at the fairest price consistent with conditions in the industry.

Membership is limited to actual commercial producers of milk, and is on a 1-year contract basis. The association has the exclusive right to market all the milk members produce. The price paid for it is determined by figuring the return from each 100 pounds of milk, this return being the weighted average of the revenue from milk, cream, butter, cheese, powdered milk, and by-products. All profits revert to members, and it is estimated that, in the twelve years since a reorganization brought the present association into being, a total of $110,000,000 has been paid them above the amount which they would have received had they continued to market their milk as they did before the Dairymen's League was formed.

The capital required for the League activities is obtained by deducting an agreed amount from the payment for each 100 pounds of milk. At the present time the deduction is 7 cents, and it is made each month. In return for this money the League





SIX HUNDRED MILK BOTTLES A MINUTE

The modern milk plant is a marvel of mechanical precision. The pictures on these two pages show a sequence of important operations in the new Dairymen's League plant, in New York, which exemplifies the highest efficiency yet obtained in an establishment of this kind. The empty bottles, in their cases, come in on conveyors at the extreme right, and are fed into five washing machines at a combined rate of 600 a minute. After a thorough soaking in an alkaline solution they are scoured inside by air-impelled water sprays, whose action is shown in the drawing above. From each washer the bottles are discharged on to a conveyor, where they are inspected. They are then carried to automatic, vacuum-actuated filling and capping machines, as illustrated on the opposite page. Meanwhile the cases have traveled through a washer and around to the fillers where they are loaded with bottles of milk by men who work at the rate of 120 bottles a minute each. Finally they pass through a chilling room and thence to the loading stations.

ssues to its members certificates of indebtedness. These are in effect notes of the organization. They run for five or ten years and pay 6 per cent interest. Of the $35,000,000 that had been thus borrowed from members at the close of the last fiscal year $22,000,000 had been repaid in full, and half of it before the certificates which represented that sum had matured.

The members use more than 22,000 trucks daily in transporting their milk to the 141 stations where it is concentrated for hauling to the cities, where it is processed and distributed. For this latter service the League owns and employs 273 tank trucks, and also makes large shipments by railroad. The manifold operations are administered from New York City, where the offices occupy two floors of a large building in mid-Manhattan.

In the past, a considerable portion of New York City's milk was sold in bulk, being dispensed through neighborhood stores as so-called "loose" milk. Some months ago legislation, actuated by sanitary considerations, was enacted to prohibit this retailing method after May 31 of this year. Its effect, so far as the Dairymen's League was concerned, was tremendous. Under prevailing practices, this concern was bottling about one-third of the milk it distributed there, selling the remainder in bulk. Pasteurizing and bottling operations were conducted in a plant at 19th Street and Avenue B, on the east side of Manhattan Island; and distribution was made from that point through four stations in various parts of the city. The 19th Street plant, which was acquired in 1921, had been built in 1916. Its facilities for bottling were being utilized to capacity, and space was not available for adding to the existing equipment sufficiently to increase the output by two-thirds.

Moreover, since the effect of the legal mandate was to increase distribution costs by approximately 60 per cent, it was incumbent upon the management to find ways and means of offsetting this impending burden by reducing expenses elsewhere; and, in view of the comparative obsolescence of the plant and its inadequacy to meet the forthcoming additional requirements, the logical course was to replace it with modern, more efficient facilities capable of handling the entire supply. The alternative was to bottle the milk at the stations in the country where it was received from the farmers; but this meant increasing transportation costs materially, since 10 gallons of milk in bottles and cases weigh 231 pounds as compared with about 85 pounds in bulk, exclusive of the container. A decision was, accordingly, made to retire the old equipment; but the question then arose as to whether one or more than one new plant should be substituted. This having been decided in favor of one large plant, and it having been determined that the 19th Street location was a desirable one from a distribution standpoint, plans were made to rehabilitate the existing building. This, too, brought its problems, for additional ground space was necessary, and little was to be had. There was also the requirement that the plant should maintain operations while changes in the structure were progressing and while new equipment was being installed.

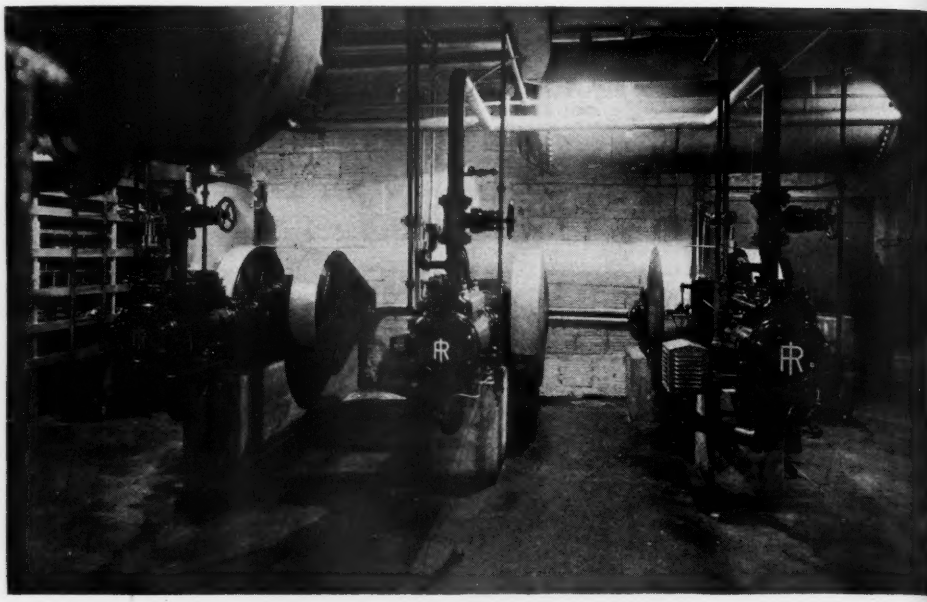
Leaving this side of the picture for a moment, we will look at another one. The existing plant was not served by a railroad, and raw milk was being shipped from receiving stations in 40-quart cans aboard cars and then trucked to the plant. As the cans, after washing, had to be returned in the same manner, about 50 per cent of the total cost was going for transportation, and it was desirable to reduce this charge. Accordingly, while plans for greater plant facilities were under consideration, the matter of economical handling of the raw milk was kept continually in mind. One possible solution was to change the location of the plant so as to have access to a railroad and to permit shipping the raw milk in tank cars; but, as previously stated, the advantage of the existing site from a distribution standpoint dictated that it be retained.

To meet this situation, it was decided to use motor-tank haulage for milk originating not more than 200 miles from the plant and to continue rail haulage for that coming from points farther away, but to adopt tank cars for the latter service. This paved the way for eliminating transportation in cans, except for a very small miscellaneous supply. In carrying out this policy, the League purchased 40 tank trucks ranging in capacity from 1,600

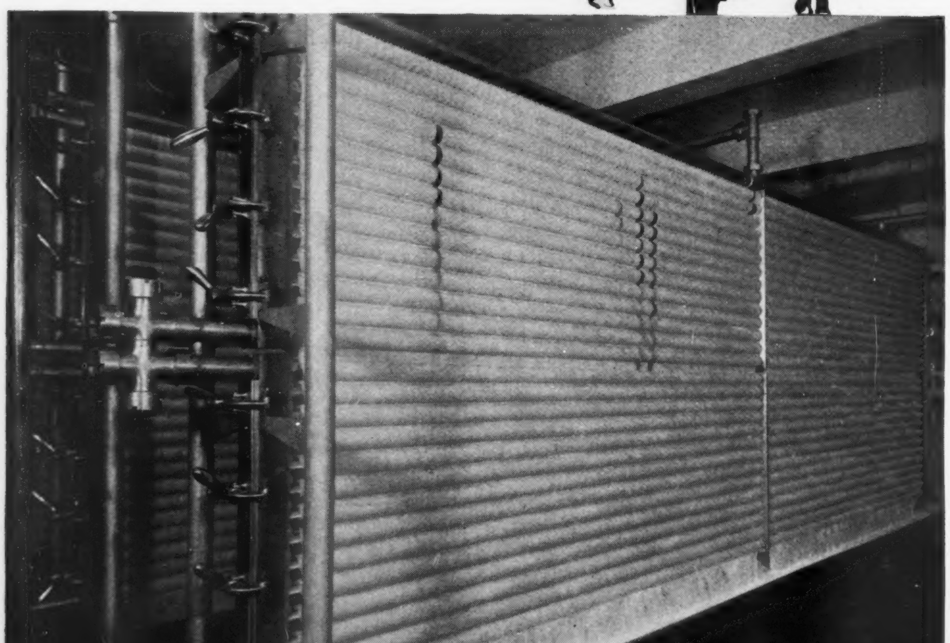
to 3,000 gallons each, and six glass-lined tank cars of 6,000 gallons capacity each. Suitable arrangements for receiving the milk under the revised transportation procedure were incorporated in the plans for rehabilitating the plant.

The old plant had a capacity for pasteurizing and bottling 20,000 gallons a day, which represented receipts from five of the fifteen gathering stations maintained in the milk-producing sections. There was storage for only 9,000 gallons. The pasteurizing was done under manual control at a rate of 18,000 pounds an hour. Bottle-washing units each handled 120 bottles a minute, the operations of each unit requiring the services of one man for inspecting and directing the bottles and of two men for feeding them. After being filled, the bottles were placed in cases, which passed to a refrigerated storage room where they were held until it was time to deliver them. This arrangement required a greater amount of ice than could be produced in the plant, and, accordingly, considerable quantities of it had to be purchased. These and other limitations and undesirable features were taken into consideration in planning the modernization; and studies were made with a view to bringing the efficiency of the plant up to the highest obtainable level. This goal has been accomplished. Thanks to the thoroughness with which A. J. Vroman, chief engineer of the Dairymen's League, investigated the situation beforehand, and to the ingenuity which he showed in the design, the rehabilitated plant functions at a lower cost per unit than any of its kind heretofore placed in operation.

This has been made possible by utilizing mechanical handling and processing equipment to the fullest possible extent, and by



Food Industries Photo

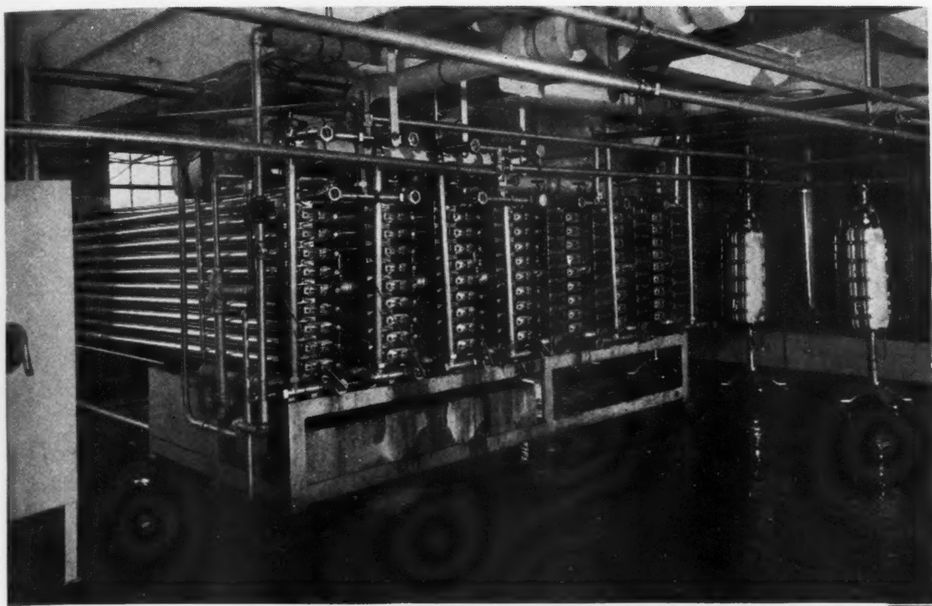


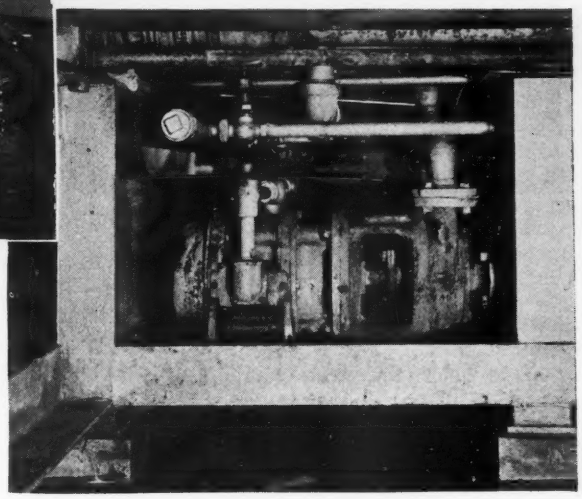
AIR COMPRESSORS AND REGENERATORS

A considerable quantity of compressed air is required in the plant, and this is supplied by the three modern machines shown above. Each unit is driven through V-belts from its own motor. To insure clean air, each intake is equipped with a filter. In the bottom picture are banks of Inconel metal tubes through which hot milk from the pasteurizers flows while cold, raw milk courses down over them. The resultant heat exchange is responsible for 80 per cent of the heating and cooling incidental to the pasteurizing cycle. The regenerators are in a glass-inclosed, air-conditioned room.

skillfully dovetailing the various essential operations so that they follow one another without delays and with but a small amount of labor and supervision. It is a surprising but important fact that more men are employed to clean the plant than to operate it. The extreme comparison of this nature is found in the pasteurizing room where, by reason of automatic control, one man easily looks after everything at night when the plant is running. By day, however, when all equipment is opened up, piping dismantled, and everything thoroughly cleansed, sterilized, and then reassembled, six men are kept busy.

In order to give the reader a general idea of the efficiency with which the new plant functions, we will sketch the principal operations in their proper sequence. The raw milk is delivered by the farmers who produce it to the various receiving stations prior to 9 a.m. There it is tested and cooled to 36°F. Soon thereafter it starts the journey to New York. The nearest of the stations is 104 miles from





HEATERS AND COOLERS

The warmed, raw milk from the regenerators is pumped through tubes inclosed within larger ones. Hot water, flowing in a counter direction through the outer tubes, heats the milk to the pasteurizing temperature. Four of the eight banks of tubes shown are heaters. The other four are coolers, and the brine circulating through them completes the cooling of the pasteurized milk which has been precooled in the regenerators. The hot water and brine are circulated by four Motorpumps housed beneath the tubing. One of these pumps is seen at the right.

the city. It and others within a 200-mile radius are served by trucks: those farther away by tank cars.

Upon arrival at the plant, the trucks drive on to one of three Buffalo scales which were installed in an addition built at the rear of the existing building. These scales weigh loads up to 30 tons and are accurate within 5 pounds. The scale beds are inclined sufficiently to permit the milk to drain out by gravity to a centrifugal pump which moves it into storage tanks on the third floor. The emptied trucks are weighed to obtain the tare, and the net weight of the milk is thus secured. Opening from the scale room is a roller conveyor for handling the relatively small quantity of milk still received in 40-quart cans. The contents of these are dumped into a tank, weighed, and then pumped upstairs.

The plant starts operating about 8:30 at night, and the duration of its run varies with the demand for milk. The raw milk begins arriving about 6 o'clock, and is usually all received during the four following hours. The storage capacity is 42,000 gallons, as compared with the 9,000 gallons previously available. It is divided among eleven glass-lined, insulated Pfaudler tanks. Owing to the special construction of the tank trucks, the milk ordinarily shows only a moderate temperature rise after the long haul; but if it is warmer than 45° it is run through a tubular-type cooler before going to storage

During the processing, the milk passes through the plant at the rate of 7,500 gallons an hour. Raw milk from the storage tanks flows by gravity to the second floor, where it falls over a Chester tubular surface regenerator, of which four are installed. As illustrated, these are banks of horizontal tubing of Inconel metal. Milk from the pasteurizers, at 143°, flows through the tubes while the raw milk courses down over them. The resulting exchange of heat accomplishes the twofold purpose of preheating the raw milk preparatory to pasteurization and of precooling the milk already so treated. Actually, about 80 per cent of the required cooling and heating is brought about by this process. The regenerators are stationed in a glass-inclosed room which is continually supplied with conditioned air. This keeps the glass from becoming fogged, and also aerates the raw milk.

The raw milk, at about 118° to 120°, is collected in a trough at the base of each regenerator and is pumped from there through one of six Wisner-Peerless double-acting filters, which remove all dirt and foreign material. It then goes to four tubular-type heaters, where its temperature is raised to the point required for pasteurization, 143°. These heaters are banks of double pipes of Inconel metal arranged horizontally. In each of the four units, the milk, flowing at the rate of 30 gpm., passes successively through the inner pipes at the various levels until it has completed the circuit. Hot water meanwhile circulates through the outer pipes in the counter direction at the rate of 150 gpm. For this service there are installed two Cameron No. 1½ Class RV-5 Motorpumps. The efficiency of these heat exchangers is such that the milk is brought to 143° by using water only one degree warmer.

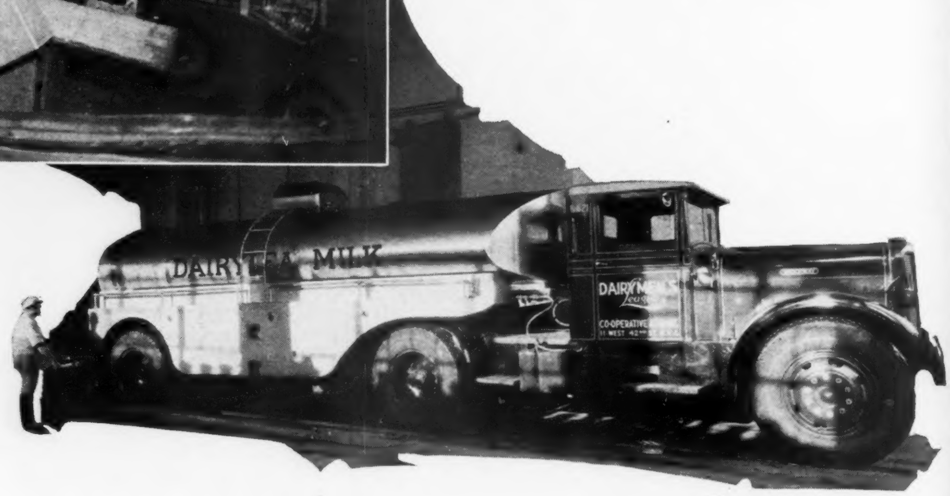
Pasteurization is effected by holding the milk at 143° for 30 minutes in Pfaudler 330-gallon holders. There are twelve of these, arranged in two groups of six each, and the milk is directed to them in rotation. It requires 7½ minutes to fill each container; and in each bank, at all times, four are full, one is being filled, and one is being emptied. The holders are filled by drawing a vacuum on them, and they are emptied by exerting pressure on the surface of the milk by means of filtered compressed air. The pasteurizing operations are entirely automatic; and the performance, temperature conditions, and other data are recorded on a central instrument board.

As already noted, the pasteurized milk flows through successive levels of the surface regenerators and is there precooled by the raw milk to about 68°. Cooling to its final temperature of 36° is then done in tubular coolers, which are identical with the tubular heaters. The cooling medium is brine, and it is circulated by two Cameron Motorpumps like those that serve the heaters. The milk then passes to 2,000-gallon balancing tanks to await bottling.

The processes just described constitute one phase of the plant operations. While they are in progress another important function is being attended to on the floor below. This is the cleansing of the bottles which are to carry the milk to consumers. These, of course, come back each day from points of milk distribution, and it is apparent at once that, unless an efficient system is followed, a great deal of expensive rehandling of them will be required. The optimum condition is one in which the bottles, upon being returned to the plant, go

ARRIVAL AND DEPARTURE

Milk reaches the plant in insulated tank trucks, below, which rest on inclined scales while their contents flow out and are pumped to storage tanks on the third floor. At the left are the loading stations. Cases of empty bottles are being transferred from trailers on to conveyors which carry them into the plant. After being washed and filled with pasteurized milk, the bottles in their cases are delivered to the trailers by the same conveyor system. The loading platform has stations for eleven trailers.



Photos, Food Industries.

through it and come out refilled with milk, thereby eliminating storage and its attendant double handling. This is seldom possible of complete accomplishment, but in this instance it is closely approached.

To quote Mr. Vroman," The backbone of a milk plant is its conveyor system," and the proof of this remark is found in the effectiveness of the one he designed for this plant. In all, there is installed about a quarter-mile of power conveyor which requires approximately a mile of driving chain. When the plant was made over, there was constructed across the entire rear of the building a platform for the loading and unloading of the trucks or trailers which distribute the bottled milk and return the empty bottles and cases. There are stations there for eleven vehicles, and each of them is served by a spur from the Mojonnier power-conveyor system. The layout and control are such that it is possible to unload a case of bottles at any station, route it through the plant, and deliver it with its contained milk back to the same station or to any one of the other ten stations. During the trip the case, although it undergoes cleaning, does not leave the conveyor.

The trailers are of several sizes, having capacities of from 420 to 580 cases. By means of the conveyor system, one of the smaller units can be loaded in as little as eighteen minutes. The trailer bodies are insulated with 2 inches of cork, which makes it possible to hold the milk in them at a low temperature until delivery time. This combination of trailers and conveyor system enables the plant to handle three times as much cased milk as formerly with the same storage space. It also reduces the ice consumption; and a 60-ton freezing field supplies the normal demand.

Upon entering the plant, the cases of empty bottles pass first through a sorting room, where those containing quart bottles are automatically separated from those containing pint bottles. Here, also, they are inspected for defects, and chipped or broken ones are removed. It may be of incidental interest to note that the average service life of a milk bottle is ten delivery trips. The cases then travel past the feeding ends of a battery of five Yundt air-brush bottle washers. There the bottles are placed by hand into openings provided for them in a revolving carriage. This operation is performed at the rate of 120 per minute by one man to a machine. This is double the speed attained in the old plant.

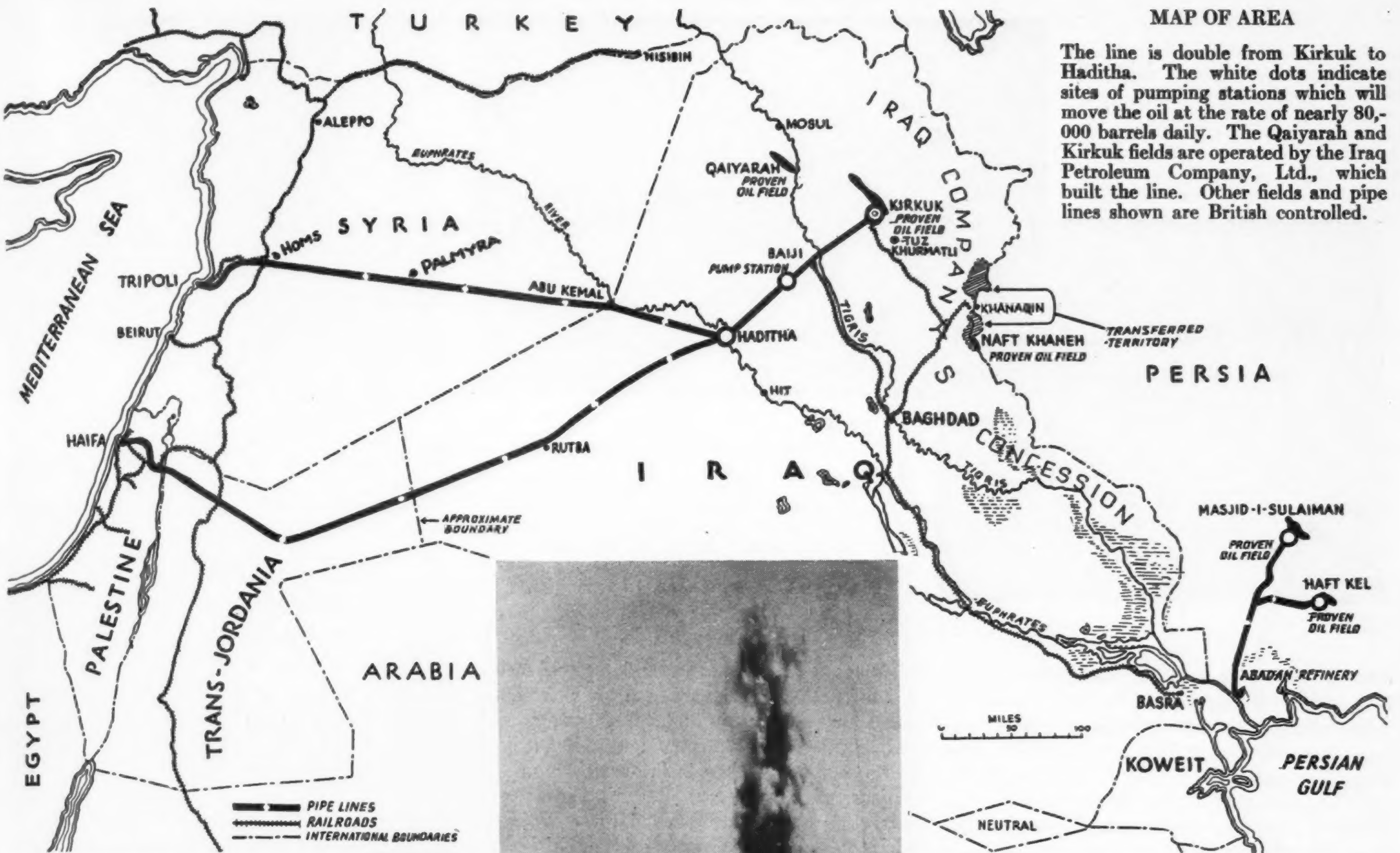
Each bottle washer is divided into two compartments: soaking tanks and washers. The bottles spend ten minutes in the first and twelve in the second. They are first soaked in water, then in successive alkaline solutions of 2, 2½, and 2 per cent strengths, after which they are rinsed. Next, the outsides are mechanically brushed. The interiors are then cleansed by jets of high-velocity water impelled by compressed air from openings in spindles which rise within the bottles as they travel mouths downward on a carriage. The jets strike one side of the bottle and spread out around its surface. This spindle is then withdrawn, after which there is inserted a second one which has its jet openings on the opposite side. As a final operation, the bottles are sprayed inside with a chlorine rinse.

Compressed air for the bottle washers, for pumping the milk from the pasteurizers, and for other uses, is furnished by three Ingersoll-Rand Class ER-1 compressors, each of 215 cfm. piston displacement. They are separately driven through V-belts from General Electric 25-hp. motors. To insure clean air, each unit is equipped at the intake with a Coppus Type FC air filter.

The bottles are discharged from the washer right side up on a conveyor, where they are inspected. They then move around to any one of six filling machines. Four of these are of Mojonnier make, and each has a capacity of 120 per minute, being synchronized with the speed of the bottle washers. The two others, which serve primarily for handling cream, are Milwaukee machines of 60 bottles per minute capacity each. Actuated by vacuum, these machines fill each bottle to a specified level without spilling a drop, and put the cap in place.

As previously noted, the cases do not leave the conveyors. After the bottles are removed from them they go to a washer, and then continue to the bottle fillers. The height of the conveyors, the delivery point of the filled bottles, and all other details are arranged so as to assure a maximum of convenience for the men who place the bottles in the cases. As a result, they handle 120 of them a minute, maintaining the same rate as that at which the empty bottles are fed into the washers. The filled cases then pass through a chill room and to the trailers.

The coal-fired boilers previously used were replaced with two 210-hp., Erie City water-tube boilers equipped with National Airoil automatic burners. There also were installed four Creamery Package Company, synchronous-motor-driven ammonia compressors of 170 tons combined refrigerating capacity. These supply the needs for ice, brine, and cooling water.



MAP OF AREA

The line is double from Kirkuk to Haditha. The white dots indicate sites of pumping stations which will move the oil at the rate of nearly 80,000 barrels daily. The Qaiyarah and Kirkuk fields are operated by the Iraq Petroleum Company, Ltd., which built the line. Other fields and pipe lines shown are British controlled.

A BLAST IN THE EUPHRATES

The Iraq Pipe Line

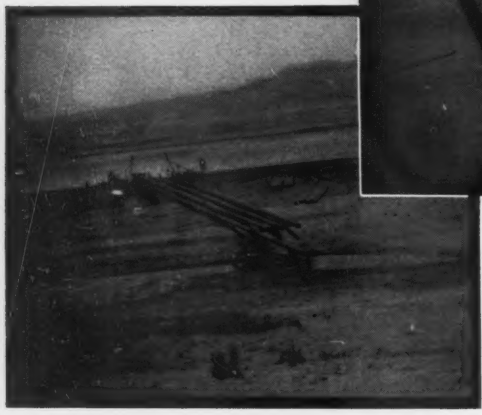
F. C. YORKE

ONE of the most imposing construction undertakings of modern times has just been completed in the cradle of Christianity. This is the Iraq pipe line, a $50,000,000 project which will furnish an outlet at two Mediterranean ports for petroleum produced in the interior of northern Iraq. Construction activities, which followed several years of negotiations and planning, were begun in 1932 and, despite the tremendous physical obstacles presented, were carried forward with such speed that the line was finished and put in service eighteen months sooner than was expected.

Pipe lines of this character cause little stir in the United States, which has a vast network aggregating 125,000 miles. Outside our own borders, however, where only 2,000 miles of petroleum pipe lines existed at the time the work in Iraq was started, an enterprise of this scope commands unusual interest. There were also other elements to draw the attention of the world to the Iraq development. It traverses a trackless waste, much of it desert where little water is to be had and where the temperature frequently reaches 135°F. in the shade. The delivery of machinery, construction materials, and supplies, the setting up and maintaining of camps, the feeding and housing of as many as 15,000 workmen, and the organizing of the manifold activities along a line that stretched out for nearly 1,000 miles, entailed great difficulties, and these were overcome only through the exercise of much ingenuity and excelling executive direction.

The Iraq pipe line extends from Kirkuk in northern Iraq, where important oil fields exist, to the two terminals on the Mediterranean coast at Haifa, in Palestine, and at Tripoli in Syria. Because of its international ownership, agreement on a single outlet was impossible, and the matter was compromised by dividing the line at Haditha and running a southern branch to Haifa, through territory under British mandate, and a northern section to Tripoli, through the French protectorate of Syria. Between Kirkuk and Haditha, a distance of 156 miles, the line is double. From Haditha, the forking point, single lines extend 375 miles to Tripoli and 464 miles to Haifa. The total length of the route is, therefore, 995 miles, and the total length of the pipe 1,151 miles. On its way through Transjordania, the southern branch passes the famous Rutbah Wells, which are well known to overland travelers to Bagdad, and crosses the Jordan River of biblical fame. From the bifurcation, the Tripoli section takes a course into Syria and the Grand Liban and passes the ancient cities of Palmyra and Homs. Throughout its course, the line consists of 12-inch internal-diameter pipe except for short stretches where dips increase the pressure sufficiently to permit the use of 10-inch and 8-inch sizes without reducing the carrying capacity.

The line was constructed by the Mediterranean Pipe Line Company, Ltd., a subsidiary of the Iraq Petroleum Company, Ltd., which holds the concession from the Iraq government to the oil fields in the Kirkuk area. The parent concern embraces oil interests of four nations. It comprises Anglo-Persian Oil Company (British), Royal Dutch Shell (Dutch), Compagnie Francaise des Petroles (French), and Near East Development Corporation (American), each of which



SECTIONS OF PIPE

Seamless steel pipe was delivered in 40-foot lengths, and then fabricated into 200-foot sections prior to being placed in the trench. At the left is a group of these sections on dollies, with the Jordan in the background. Above is a close-up of these 12-inch pipes.

CROSSING THE JORDAN

A double line of pipe was laid across this historic stream. Pictured above is a blast in the river bed.

owns 23¾ per cent of the concession. The Near East Development Corporation is participated in by the Standard Oil companies of New Jersey and New York, and the Gulf Refining Company. The other 5 per cent is held by Participations & Investments Ltd., in which C. S. Gulbenkian, a Turk, is the dominating factor.

The detailed history of the developments which led up to this concession is too long and involved to repeat here. The matter of grants for oil prospecting in the area concerned has been an international football for many years and dates back to the time when the territory was known as Mesopotamia. It is significant to note that, whereas petroliferous materials have been known to exist in this portion of the earth for many centuries, the discovery of the Iraq fields was made only recently. The pitch with which Noah calked the ark is said to have come from springs not far from this new pipe line; and deposits of asphalt reach the surface at various points in this general area. Prospecting of the deeper strata for petroleum was delayed in the interior regions, however, because of the physical and climatic obstacles, the unfriendliness of the desert tribes, and the political complications which were involved. The first concession was granted in 1902, but nothing came of it. During the war Germany drilled several wells in the Mosul-Kirkuk area, but they were carried downward only 200 or 300 feet and yielded little.

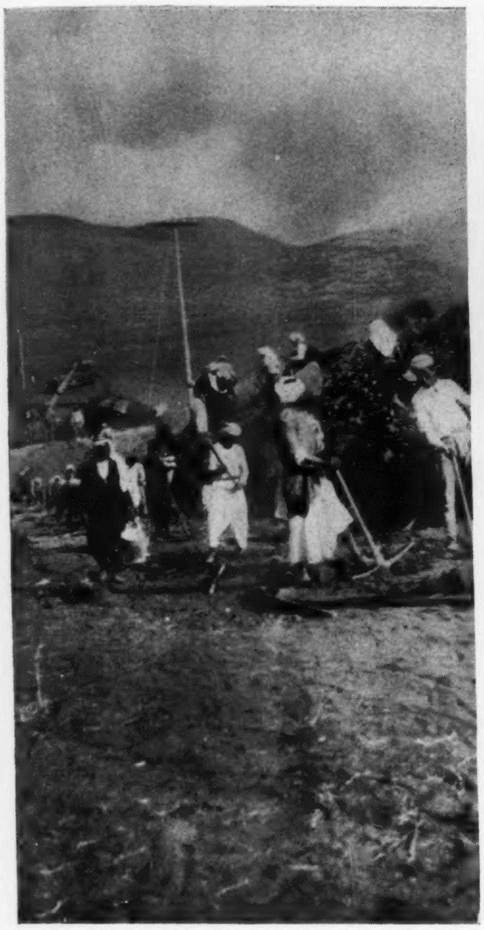
After much juggling of the rights to prospect the territory, the Turkish Petroleum Company, forerunner of the present Iraq Petroleum Company, made the first important strike in 1927. The production of the discovery well was estimated variously at from 15,000 to 100,000 barrels a day: no official figure seems to have been reported. Neither is the extent of the field publicly known. Only about 30 wells have been drilled thus far, and those which turned out to be producers have been shut in awaiting adequate means of transportation to refineries.

The Kirkuk structure is a narrow anticline about two miles wide and variously reported to be from 40 to 100 miles long. Regardless of the lack of authentic information on the subject, the willingness of the interested parties to spend $50,000,000 for a delivery line is sufficient evidence that a field of huge potential production exists. The oil is found in a limestone formation which ranges from 500 to 1,000 feet in thickness and which will, it is believed, yield at least 15,000 barrels for each acre of its surface. This reservoir rock lies at a depth of only 3,000 feet, which promises comparatively inexpensive drilling. The oil is of 36° Baumé gravity and of mixed paraffin and asphalt base. The Iraq Petroleum Company also has developed production in the nearby Qaiyarah field, but the oil there is heavy and therefore not so desirable as that from Kirkuk.

The pipe line is made up of seamless steel tubing which was delivered in 40-foot lengths and welded into a continuous section. The first important step following the laying out of the route was the placing of orders for the 123,000 tons of pipe required. To insure deliveries at a rate that would permit rapid fabrication of the line, and also because the interests of several nations were represented in the ownership, contracts for the pipe were divided among four countries. By reason of the existing difference in price, the United States did not share in the orders for 12-inch pipe, which constituted the major portion of this material. It was produced by mills in France, England, and Germany. Some of the 10-inch and 8-inch pipe was manufactured in America.

While the pipe was being made, preparations for laying it were going forward in the field. Chief among the problems involved was that of transportation in a region of few railroads and no highways. Tractors mounted on crawlers, and trucks manufactured especially for the purpose in several countries, were utilized for this service; and during the course of the work some units of impressive size and power were developed. One American-made outfit, consisting of truck and trailers, measured 100 feet in length and had 30 wheels in contact with the ground. This conveyance weighed 20 tons and proved capable of hauling loads of 40 tons. The chains and bolsters which were employed in making the load secure weighed as much as an ordinary passenger automobile.

Between Kirkuk and Haditha the route crosses both the Tigris and Euphrates rivers, and special provisions had to be made for transporting materials across them. After a study of the situation it was decided to erect aerial cableways of the sort much used in mining and construction operations. On either side of the Tigris, which has a normal width in flood period of about 1,500 feet, 140-foot towers were erected. The span between them was 1,985 feet, and the line had a clearance of 80 feet when carrying a normal load of 3½ tons. This cableway was designed to operate at a hoisting speed of 125 feet per minute and a traveling speed of 500 feet. The Euphrates cableway had a span of 1,830 feet between 130-foot towers. Its normal load was 5 tons, and in some cases loaded trucks were



PALESTINIAN LABORERS

Workmen were drawn largely from the districts traversed. The scene of this picture was the Jordan Valley.

CROSSING THE EUPHRATES

Both the Tigris and Euphrates rivers had to be crossed by the double section of the line, the pipes being laid underwater. To facilitate distribution of pipe and other materials along the line, aerial cableways were constructed to span both of these streams.

transported by it. Hoisting and traveling speeds were double those of the Tigris installation.

The pipe for the petroleum line and the machinery for the pumping stations which are disposed along its course constituted the heaviest and bulkiest of the materials which had to be handled; but there was also a huge amount of water pipe, telephone and telegraph standards and wires, building supplies, food, and other essential materials and equipment that had to be moved. These had to be delivered for distances up to 250 miles from the nearest railroad terminals. The intervening terrain varied from mountain passes, at elevations as great as 3,150 feet, to shifting desert sands and sinks as low as 800 feet below sea level.

During the summer months the temperature in the sun sometimes reached 150°F., and even inside a driver's cab it was impossible to touch the gear-shift lever without the use of gloves. In some sections sandstorms raged with such intensity that a truck driver could not see the radiator cap a few feet in front of him. The sand sifted into the cab through the most minute cracks; and, in extreme cases, drivers were even compelled to stop their machines and to take refuge under them, covered with a tarpaulin, until the worst of the storm was over.

The foregoing gives a hint of the difficulties which nature imposed upon the pipe-line builders. These were not only trying for the men but also impeded the efficiency of the various classes of machinery employed. As bases of operations, twenty camps were located at intervals along the line, and in these the workers were made as comfortable as the prevailing conditions would permit. Although the work was directed by Americans and Europeans, much of the labor was drawn from local areas, and as many as twelve nationalities were represented. In many cases the sanitary ideas of these natives differed from those which prevail on well-ordered, modern construction jobs, but, in the interest of general health, strict regulations were enforced. Hospitals were established, medical attention was made available to everyone, water supplies were carefully watched, wholesome food was provided, and various other precautions were taken to guard against sickness and to maintain morale. It was noteworthy that the general physical condition of the natives improved under this mode of living, and in most instances they gained in weight even while engaged in hard physical work under severe temperature conditions.

The line was buried throughout its course. This required the opening of a trench approximately 22 inches wide and 3 feet deep and called for backfilling after the pipe had been laid. Trenching machines could be used on a considerable portion of the route, and eight Buckeye units powered with Waukesha engines were employed. In numerous zones, however, the surface consisted largely of rock, which necessitated drilling and blasting the trench. The most severe conditions were encountered in Transjordania, where the line traverses what is known as the lava country. In this 100-mile section there was much solid rock as well as basalt bowlders of all sizes. Basalt was also found between Tripoli and Homs and on the west bank of the Jordan River. Limestone, flint, and chert occurred at intervals all along the line outside the basalt areas; and in Iraq, between Haditha and Wadi Tharthar, a gypsum bed almost 40 miles across was met. Even in stretches which consisted principally of earth, occasional bowlders were struck, so that drilling and blasting had to be employed to some extent throughout the entire length of the line.

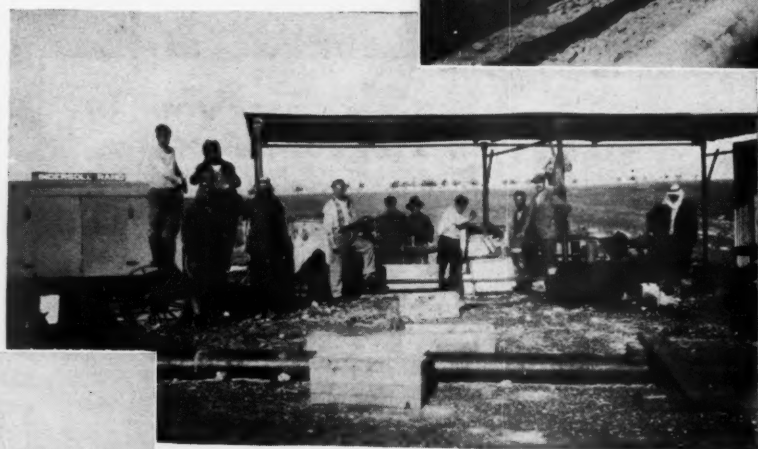
All rock excavation was handled with compressed-air tools, and these were furnished power by 60 Ingersoll-Rand Type 20 portable compressors of 5½x5-inch size. The compressors were distributed among the various gangs, and with each of them went a complement of R-39 "Jackhamers" and CC-45 paving breakers. The lava country presented the greatest amount of work for these machines, and twenty compressor outfits were used there. Between January and September, 1933, they operated double shifts of sixteen hours from sunrise to sunset. In this section, alone, some 500,000 holes were drilled and blasted. The holes ranged in depth from 18 inches to 5 feet and averaged around 3 feet. Because of the bowlder formation, a second and even a third drilling and blasting were many times required in the same location.

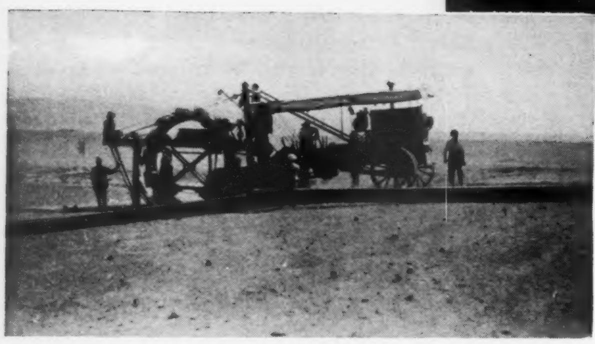
Owing to the difficult service imposed upon them, it had been expected that a considerable number of the compressors would be unfit for further use after they had completed this part of the ditch. A check of them, however, revealed that every one finished the job in serviceable condition. The drills and paving breakers gave similar creditable performances, and there was not a single case on record of a broken piston.

The conditions under which this equipment worked during the period from May to September were especially hard. The temperature ranged from 105° to 120°F. in the shade; and, under the 16-hour daily schedule which was followed, a rigorous test was imposed upon both compressors and tools. Owing to the

GLIMPSES OF THE WORK

Except in rocky ground, the trench was dug with Buckeye ditchers powered by Waukesha engines. The bottom picture shows one of these machines in operation. Blacksmith shops had to be moved frequently, and were constructed with this in view. In the center, one of them is shown being dismantled. The section of 12-inch pipe in the foreground was made into an auxiliary air receiver by sealing its ends. The picture at the right was made at Haditha and shows a group of Iraq laborers.





SOME CONSTRUCTION HEADS

Many of those prominent in directing the work were Am icans. The figures (opposite page) designate the follow persons: 1—H. S. Austin, chief engineer; 2—J. W. Lightf gang foreman; 3—B. J. Davis, welding superintendent; C. A. Mulligan, construction superintendent.

prevalence of dust, the machines were subjected to unusual wearing action, and to offset its effects lubricating oil was renewed at frequent, regular intervals.

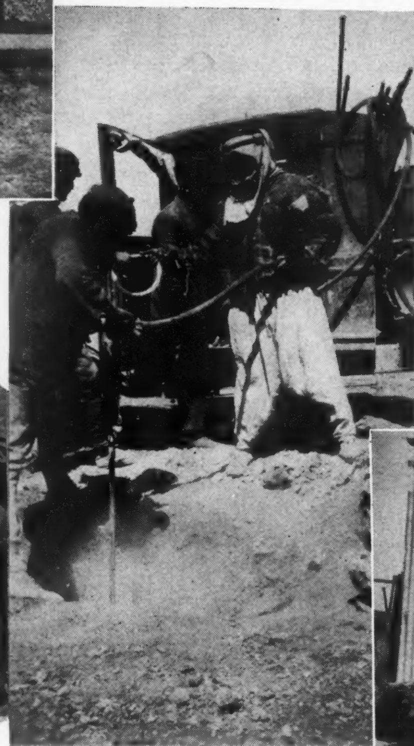
A modern blacksmith shop was provided to maintain the equipment of each ditching gang. This work included the reconditioning of drill steels and ditching-machine rooters, and general repairs of all machinery. Each such shop consisted of a corrugated-iron structure, 30x15 feet in ground dimensions and 10 feet high, and was erected so that it could be easily dismantled and reassembled with each change of camp site. Extra air-receiver capacity was provided by welding the ends of a 40-foot section of 12-inch pipe and fitting it with 2-inch inlet and outlet pipes and a ½-inch drain valve. By running a special 2-inch flexible connection from the aftercooler of the Type 20 portable compressor, which served the shop, to this auxiliary receiver, vibration was entirely eliminated from the air lines. The added receiver capacity served to maintain an adequate pressure for the working of the shop equipment. Each shop contained a No. 40 drill-steel sharpener complete with shank and bit punch, a No. 26 oil furnace, a No. 8 pedestal grinder, an E-44 power hammer, a Type "C" pneumatic or post drill, and two or three hand forges.

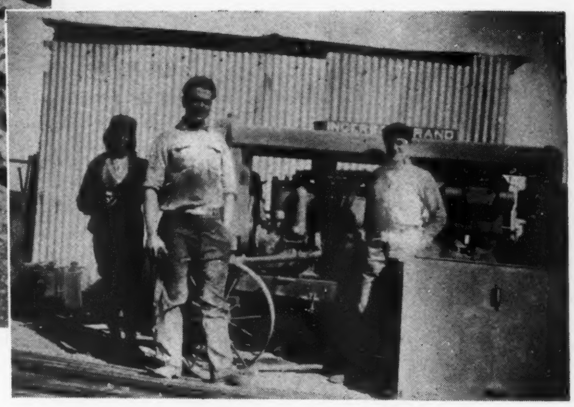
The labor required for operating the drills and compressors and for performing the various other jobs was recruited locally. Most of the men came from the native villages, often leaving primitive life amid their camels and small holdings which date back to ancient times, to become operators of modern machinery. Despite their unfamiliarity with mechanical things, they learned quickly, and soon adapted themselves to their new duties. The head blacksmith was usually a man who followed that calling in his native surroundings, and in nearly all cases they became first-class sharpener operators. In the lava country as many as 600 to 800 drill steels were sharpened daily.

During the hot-weather period previously referred to, the work of preparing the trench was being rushed to keep this operation ahead of the welding gang which was approaching from the Palestine end. By doubling the shift, it was possible to drill and blast more than a mile of ground every day. The broken material was removed from the trench by native laborers. During this rush period the only attention that had to be given the compressors consisted of grinding and adjusting the engine valves, changing and cleaning the compressor valves, and taking up bearings.

The "Jackhamers" used hollow hexagon drill steel of ⅞-inch section which was delivered as bars and made up into suitable lengths on the job. The most common length was 42 inches, bearing 4-point cross bits 1⅝ inches in diameter. Side holes in the bits were found most suitable in the lava country. The paving breakers used 1¼-inch solid hexagon steels in 24-inch lengths for ordinary work. In many cases, where drilling with "Jackhamers" was impossible, these tools were used with 40-inch steels to punch holes for blasting.

The usual practice was to drill and load from 100 to 300 holes and to shoot them all at one time. Blasting operations were of especial interest to the natives, most of whom had never witnessed anything of this sort. On one occasion, when the Emir Abdulla of Transjordania visited the work, 2,500 holes were shot by progressive series, giving the effect of a creeping barrage reminiscent of wartime. It is estimated that somewhere between 200 and 300 tons of explosives were used on the job. On the eastern, double section of the line and on the southern branch to Haifa, Nobels 42 per cent gelignite was mostly used, the remainder being 62 per cent gelitine. On the northern branch, French-made explosives of various strengths were employed. Although native unskilled labor was quite largely used in the blasting work, the opera-





WHERE DRILLS HELPED

Despite the heat and sand storms, compressed-air equipment withstood the rigorous service in splendid fashion. A drilling scene along the pipe line is shown at the top, left. Drills were also used extensively in preparing blasting holes for the telephone line through Iraq. The center picture shows Iraq laborers engaged in this work. A Palestinian blacksmith and two of his helpers at the Aratain camp in the lava country are shown below.

tions were supervised so carefully that very few accidents occurred.

The initial operation of preparing the pipe for placing in the ground consisted of welding five 40-foot lengths together. To facilitate turning the pipe for making the welds, and to keep the lengths involved at the same level, they were laid on supports. Each pipe length had belled ends, and in making a joint a chill ring was placed inside in such a position that each of the adjacent bells fitted over one half of it. By this procedure it was possible to prevent lags of metal from projecting into the interior of the pipe as a result of the welding process so as to insure a free and unobstructed flow of the oil.

The 200-foot sections thus formed were then joined to make up the completed line. In doing this, the sections were picked up by cranes mounted on crawlers and moved into position directly over the open trench, where they rested upon wooden skids stationed 70 yards apart. By design, this resulted in the sagging of the sections between the points of support, thereby serving to make the line slightly longer than the trench and insuring that the sections would be joined together under compression rather than under tension. This surplus length provided leeway for expansion and contraction owing to temperature changes. To escape the expansive effect of the exceedingly hot middays, efforts were made to conduct the pipe-laying operations during the cool morning hours so far as this was possible. The 200-foot sections were joined by welding, and as it was necessary for the workers to have access to the under portions of the pipe, the trench was widened out where sections came together to provide sufficient room for this purpose.

After the welding was completed, and while the pipe remained supported on the skids, it was cleaned by means of an ingenious self-propelled machine carrying a series of rotating wire brushes whose action left the surface free from all dirt and other adhering material. Extensive precautions were taken to protect the pipe from corrosion. A primer coat of bitumastic was applied, and, after this had dried, the pipe was wrapped spirally with strips of asbestos felt 12 inches wide. This waterproofing material was delivered to the job in rolls, and a total of more than 4,200 miles of it was used. The wrapping was done by machines designed especially for that purpose. A coat of bituminous enamel was applied on top of this covering. The line was then lowered into the trench by tractor-mounted cranes. These last-named machines aided materially in maintaining a rapid rate of progress and served a variety of purposes. For instance, where it was necessary to bend the pipe in conformity with a curve in the trench, or with a sharp rise or fall in grade, this was done by two sets of tractors, one of which held the pipe while the other pulled it in the opposite direction. Equipped with a scoop, these tractors also served to backfill the trench after the pipe had been laid in it.

Telegraph and telephone lines parallel the pipe line throughout its course, and seven stations have been provided along the route. The construction of these communication facilities was a large-scale operation, in itself. Wherever conditions permitted it, holes for the metal posts were dug with machines. In rocky sections, drilling and blasting were resorted to. On the southern line through Iraq, between Haditha and the Transjordania border where it was desired to complete this work quickly, an I-R portable compressor mounted on a Chevrolet truck permitted fast movement between hole locations. This machine furnished power for operating an R-39 "Jackhamer" and a CC-45 paving breaker.

The development of an adequate supply of water also formed a sizable and important task. In much of the territory where operations were carried on there was virtually no water other than a few wells which have been

oases for desert caravans for many centuries. Portable drilling tools, mounted on 5-ton trucks, were used to drill wells to depths of from 300 to 600 feet at various points, and in most cases the efforts were successful. Where drilling failed, pipe lines were laid from rivers to the camps.

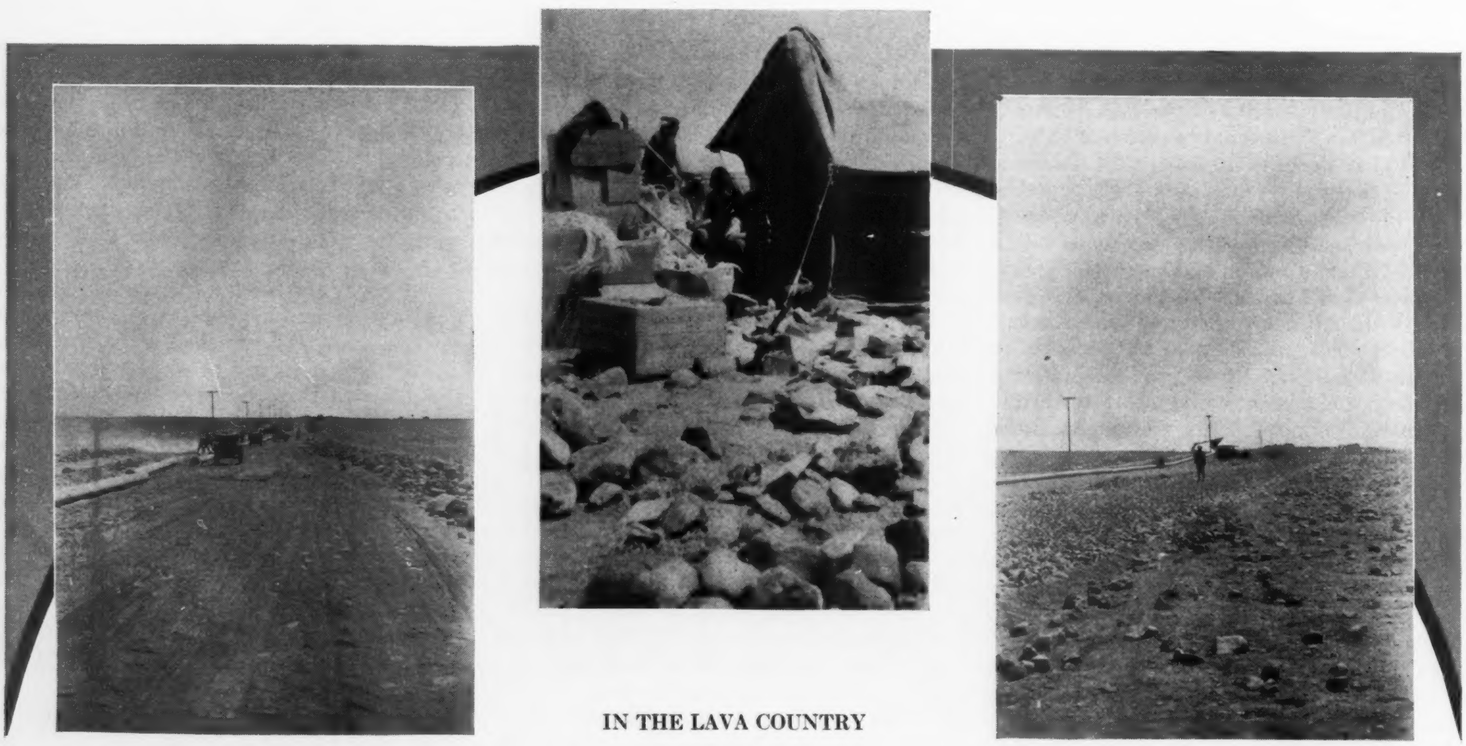
Another important auxiliary activity was the construction of a road along the pipe-line route in the lava country where the surface of the ground was so irregular as to make truck travel extremely difficult. This was built by hundreds of natives, who laid rocks by hand to form an even base. It was later dressed with crushed stone and lava ash. The ash occurred at intervals close to the road or in nearby hills, and was drilled and blasted from these locations. This highway, although constructed somewhat according to primitive ideas, served its intended purpose admirably. Prior to its existence it was impossible to drive through the country faster than from five to ten miles an hour; but after it was open to traffic speeds up to 35 miles an hour could be attained without difficulty.

For moving the oil through the line, twelve diesel-engine-powered pumping stations have been provided. Three double stations are located on the double section of the line between Kirkuk and Haditha. Four stations serve the branch on the north, and five stations the one on the south. Storage tanks of 30,000-gallon capacity are provided at each station. These are of riveted construction and were fabricated with the aid of 6A riveting hammers and Size "C" pneumatic drills, which were supplied with air by a 5½x5 Type 20 compressor. A No. 8 pedestal grinder was used for tool dressing. Substantial buildings were constructed at each station to provide living quarters for the operating personnel. These were built of stone produced in local quarries with R-39 "Jackhamers" operated by Type 20 compressors and dressed by pneumatic scalers and picks.

In view of the vast experience of American oilmen in pipe-line construction, and the participation of American interests in the development, it was but natural that this country should be drawn upon for many of the men in the key positions and for a large number of engineers and skilled workmen. H. S. Austin, president of the Ajax Pipe Line, served as chief engineer, having been loaned for the period of the construction by the Standard Oil Company of New Jersey. M. M. Stuckey, who had charge of the building of the Andean National Pipe Line in Colombia, was enlisted as assistant to Mr. Austin. Clarence A. Mulligan and George O'Connor, both of whom have been identified with numerous pipe-line projects in the United States, filled the respective positions of superintendent and assistant superintendent of construction. Numerous other Americans participated, and among these were all the welders employed on the undertaking.

The capacity of this new line is 28,332,000 barrels a year, or slightly less than 80,000 barrels a day. This is equivalent to 4,500,000 tons annually, and is 50 per cent more than the Iraq Petroleum Company, Ltd., bound itself to produce and deliver in its contract with the Iraq government. This agreement calls for the payment of a royalty of a shilling a ton to the Iraq government which, accordingly, will profit to the extent of somewhere around $1,000,000 a year. It is expected that a considerable portion of this money will be expended for the development of the country and that its position in world affairs will be correspondingly elevated.

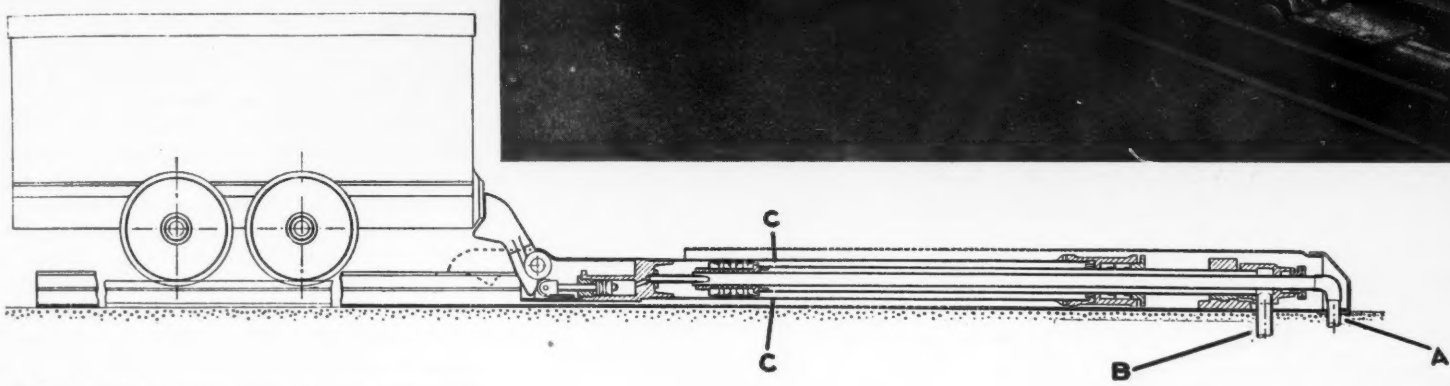
The decision to make Haifa one of the terminals of the line was the occasion for the inauguration by the Palestine government of extensive improvements in that city's harbor. Approximately $6,000,000 has been spent there. By inclosing a part of the harbor between two breakwaters, one of them a mile and a half long, an area of 300 acres of sheltered water has been provided. A bulkhead was constructed offshore, and the space behind it filled in with sand pumped from the harbor bottom. This bulkhead now provides about 700 yards of docking space, sufficient for several large steamers. The Royal Dutch Shell Company has constructed in Haifa a refinery having a capacity of 1,260,000 barrels a year. Thus far this offers the only facilities on the eastern shore of the Mediterranean for treating the crude oil which the pipe line will deliver. Accordingly, all but a small portion of the Kirkuk petroleum will be shipped in tankers to various European countries for refining. The effect of the influx of this additional supply upon market conditions is yet to be determined; but, inasmuch as the membership of the Iraq Petroleum Company comprises the most important interests in the industry, it is felt that steps will be taken to prevent any undue disturbance from this source.



IN THE LAVA COUNTRY

Through Transjordania the line traverses a lava formation, and more than 500,000 drill holes were required to excavate the trench in this section. On the left is a line of portable air compressors and drillers. The right-hand view shows a signalman waving an "O.K." to blast. He is standing on the remarkable cobblestone-base road that natives built along the line. Transjordanian powder monkeys are pictured above at their work of preparing explosives for use.

Air-Operated Pusher of Novel Design for Mine Cars



SHOOTING mine cars to and fro under the impulse of pneumatic rams for loading and unloading is nothing new; but the Isselburger system of propulsion developed in Germany has some novel aspects. What differentiates it from other similar devices is that it operates in a somewhat reverse order—that is, the cylinder is made to move and not the piston with its rod, as is usually the case. The latter remains stationary—its after end being firmly anchored.

Attached to the forward end of the new catapulting mechanism is a movable arm or pusher that is brought to bear against the end of the car and gives it the impact that sends it on its way. This arm turns about a pin, and is raised to the proper height by an auxiliary cylinder that obtains the air necessary to drive its piston from the main air cylinder. Upon the return stroke of the piston the arm is caused to drop without coming in contact with the axle of the car, and is pulled backward.

The compressed air through which the arm is given its driving power is admitted at A, as shown in the accompanying sectional drawing. The air flows into and through the hollow piston rod, and thence into a small pipe inserted at its front end. This pipe connects with the auxiliary cylinder, and supplies it with sufficient air before the beginning of the propulsive stroke to raise the arm. The forward movement of the ram, itself, is effected by air from the same source but which flows out and along the exterior surface of the pipe. This builds up pressure behind the head of the cylinder, causing it to advance slowly at first and then faster until it attains maximum speed when the small air pipe is withdrawn from the piston rod.

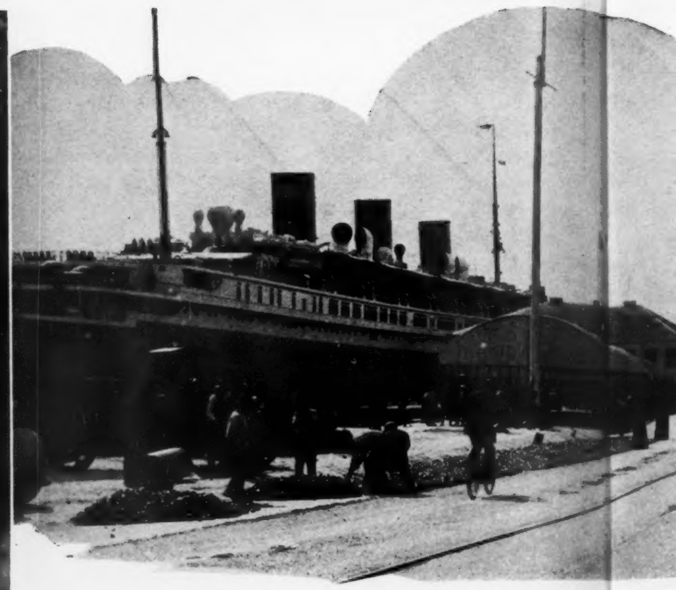
To effect the return stroke, the air supply is shut off and the air remaining in the hollow piston rod is permitted to flow through two small openings, C, into a chamber immediately back of the piston, thus exerting pressure against the opposite end of the cylinder and forcing it back to the starting position. This stroke is cushioned by admitting air at B, making it possible not only to temper the blow but to stop the cylinder at any point in its travel if it is desired to speed up the loading operations. Damage from falling objects and jamming are prevented by a stout, metal plate that covers the piston rod from end to end and even protects a part of the cylinder when the latter is fully extended. The mechanism is thus kept clean; and it operates with little wear and tear and attention.

The Isselburger pneumatic ram is designed to handle one or two mine cars and to engage either the end of the car, as illustrated, or the underframe. In the latter case, a stroke of 4.25 feet is sufficient to shove one car—the length of the mechanism, when fully extended, being approximately 14 feet. The accompanying photograph, which was taken in the Victor Mine of the Kloeckner-Werke, A. G., at Rauxel, shows two empties with the pusher or arm in position ready to send them to the loading station. This ram has a stroke of 13.5 feet and a total length, with the cylinder entirely withdrawn, of 32.5 feet. The same type for but one car has a stroke of about 6 feet and an over-all length of approximately 18 feet. The height and width, in both cases, are 8 and 13 inches, respectively.

This method of propelling mine cars is being used successfully, so it is reported, both above and below ground in a number of German mines.

WHERE NATURE LAVISHED HER GIFTS

One hundred thirty years ago the brilliant Irish poet, Thomas Moore, found residence in the Bermudas so monotonous that he forsook a fat government post after a few months to return to the gayety of England. Nowadays, however, these sun-bathed isles, which have kept the pulse of life at a slow beat, offer a welcome haven to thousands of Americans who seek a brief respite from the blare and hustle of their mechanized sphere. Cycling is more than a sport in Bermuda: it is a major means of transportation. One of the ladies pictured is unmistakably American, for she is momentarily forgetting the "keep-to-the-left" rule of the road that prevails there.



ALONG THE WATERFRONT I

**Hamilton is the trade center and seat of ins
liners pick their way through a reef-lined c
Front Street, the chief avenue of commerce.**

The Islands the Nor

ALTHOUGH best known for its equable climate, Bermuda, with its associated islands, is interesting for various other reasons. Save for St. Helena, where Napoleon spent years of banishment, it is the most isolated land on earth. The eastern coast of the United States and the Bahamas, both more than 500 miles away, are its nearest neighbors. Consisting all told of less than twenty square miles of land—about the same area as Manhattan Island—the Bermudas form but a dot on the map of the world. They were discovered by accident early in the sixteenth century when Juan Bermudez drifted there after his ship had been wrecked while on its way from Spain to Cuba with a cargo of hogs. The next two visitors were likewise victims of marine disasters: Henry May, an Englishman, in 1593, and Sir George Somers, in 1609.

Bermuda originated in an unusual manner. In some remote geologic era, volcanism formed a mountain there that extended from the sea floor almost up to the surface. Coral polyps took up their abode on the submerged peak, and through hundreds of generations their accumulating skeletons built up the surface a few feet. Then, during the first glacial period, the sea receded and exposed the tip of the volcano with its crown of coral rock. Erosion of the surface produced fine coral sand, and the prevailing winds carried quantities of it to the southern section of the island and there heaped it into a mound. When the ocean surface rose to its former level during the succeeding interglacial period, only this highest area remained above water. Coral activities built more rock offshore; and, when the sea again fell, more sand was formed and drifted on to the mound. Meanwhile, vegetation which had taken root on the older deposits was buried with them. In all, this cycle was repeated four times. Thus, the present Bermuda is a true wind-blown or aeolian limestone, one of the few such formations known.

The rock is extensively utilized for building purposes, since it is virtually the only material of the

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WATEFRONT IN HAMILTON

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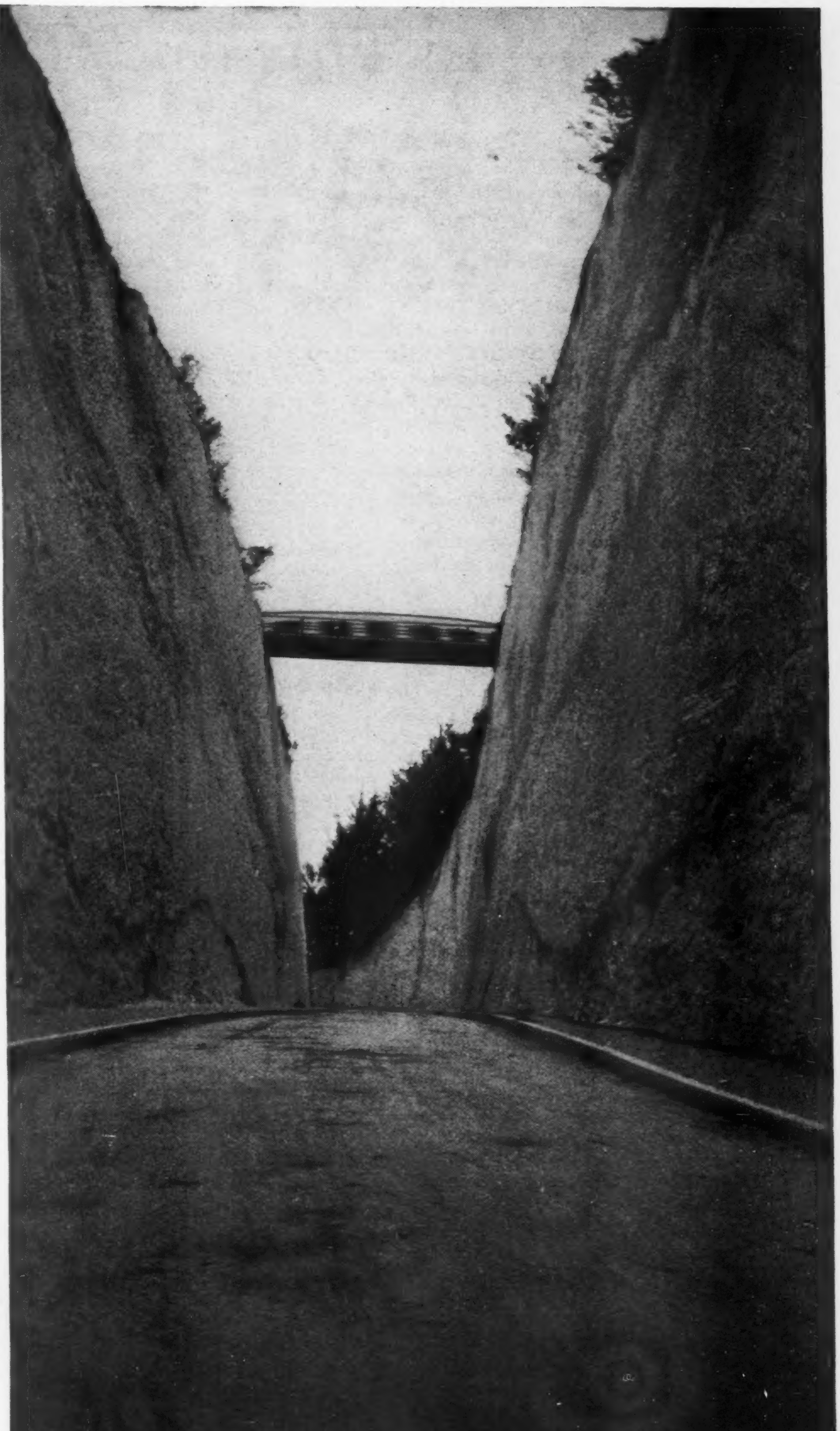
kind locally obtainable. The average thickness of the soil mantle is said to be but 6 inches. The normal procedure in erecting a house is to excavate the basement and to use the resulting rock for the walls. Newly exposed stone is soft and is sawed into blocks of suitable dimensions with an ordinary heavy wood saw. It is cream colored when quarried, but weathers to a dark gray and gradually increases in hardness.

Bermuda is one of the few places that exist without automobiles by choice. Pleasure cars are banned, and there are only a few trucks. Until 1931, the populace and visitors depended entirely upon bicycles, horse-drawn carriages, and boats for transportation. A railroad which runs the length of the scythe-shaped chain of islands was opened that year.

Although the land is nowhere wider than two miles, the wind-borne sediments were heaped up to such an extent that maximum elevations of 260 feet now obtain. The topography is surprisingly rugged, and cuts of considerable depth are found along the routes of the railroad and the highway system. The hewing of the soft rock was formerly done with hand-wielded implements; but in recent years portable air compressors and accessory tools have come into use. Drilling and blasting are not necessary: paving breakers, air-driven spades, and allied tools serve to accomplish the demolition at a good rate of speed. The limestone stands well, and the sides of even high cuts are left nearly vertical

Bermuda is a British possession, and because of its strategic location England maintains a garrison of troops there. The naval base includes a dry-dock which was towed across the Atlantic. A governor appointed by the crown also acts as commander-in-chief of the military forces and is always an officer of the British army. He rules the islands with the aid of nine members of the legislative council, who are also appointed by the crown, and of an elective legislative assembly made up of four members from each of the nine parishes. The population numbers about 30,000 persons, of whom one-half are whites.



A THOROUGHFARE HEWN FROM ROCK

Although the pleasure automobile has not yet invaded Bermuda, the art of roadbuilding is well advanced. In many places where routes traverse hilly sections, grades have been kept down by making cuts through the soft limestone. The artificial canyon shown above has almost vertical sides rising more than 100 feet. Bermuda is composed of wind-blown sediments which rest upon the top of an inactive volcano. They were deposited in four successive periods, giving rise to a semblance of stratification which is discernible in this view. The marl-like limestone consolidates into hard, fairly smooth road surfaces which dry quickly after the frequent showers.

This and That

Poison Gas to Guard U. S. Gold

SINCE Uncle Sam took charge of all the country's gold he has been giving some thought to its effective husbanding. To discourage any enterprising safecrackers who might be plotting a super job, the Treasury Department is preparing a veritable Gibraltar to guard the $7,755,000,000 hoard which it has assembled. At a cost of $390,000, steel-and-concrete vaults are being constructed in Washington. The walls will be 27 inches thick, interlaced with ganglia of burglar alarms, and built to resist melting and boring. Passageways through which armed guards will pace are being provided; and, just as a final precaution, tanks containing poison gas are being arranged so that they will pour forth their noxious fumes to greet any unauthorized intruder.

* * *

Life of Railroad Locomotives

THE MAN who drives an automobile that is eight years old fancies he hears a muffled snicker from the roadside now and then. It may afford him some solace to know that even our best railroads are running locomotives that far antedate his battered bus. According to a report by Joseph B. Eastman, Federal Coördinator of Transportation, the average age of the 51,425 locomotives owned by Class 1 railroads in the United States is 20.7 years. Moreover, it is expected that nearly 21,000 of the 27,598 locomotives that are now over 21 years old will still be in service at the end of 1938. These figures are based on the service-expectancy of this class of equipment. The oldest locomotive found to be in serviceable condition was built in 1865. The average ledger value of the locomotives is $33,402. The average annual depreciation charge is equivalent to 2.19 per cent of the first cost, indicating that the anticipated service life of a locomotive is 46 years.

* * *

The Debut of the Air Train

A PREVIEW of the coming mode of air transportation has perhaps been presented in Russia, where gliders have been towed by an airplane from Moscow to Koktebel, Crimea, a distance of more than 800 miles. Upon reaching their destination the gliders were detached separately, while aloft, and made perfect landings. This is said to be the first flight of its kind in the history of aviation.

The Russian "air train" consisted of three small gliders which were connected directly to the fuselage of the plane by means of cables which could be simply and quickly released. The gliders were not in line, but in a roughly fanwise formation, creating with the plane the corners of an irregular diamond. Each glider carried a pilot and 45 pounds of cargo.

The object of the Crimean journey and of the test flights that preceded it is to suggest a means whereby such "air trains" could be utilized in carrying passengers, mail, and express. For instance, a plane towing three gliders might take off from New York for Chicago. Over Harrisburg, Pa., one glider might cut loose and soar to the ground without delaying the progress of the other units. The second might alight at Pittsburgh, and the third at Cleveland, while the plane proceeded to Chicago.

* * *

The Luck of the Browns

IN HIS recent book, *Timberline*, which is the saga of two Denver newspaper publishers and has nothing to do with trees, Gene Fowler gives some incidents in the life of Mrs. J. J. Brown, who, following her rescue from the ill-fated *Titanic*, acquired the sobriquet "The Unsinkable Mrs. Brown." Mrs. Brown made the front page of every daily paper in the land when fellow occupants of a lifeboat told how she had buoyed up their spirits by her indomitable courage and had even spurred the oarsmen on with lusty curses when they showed evidence of tiring. At the time she left the ship, Mrs. Brown was liberally and expensively attired, her garments including a $60,000 chinchilla opera coat. Perceiving that others in the open boat were shivering, she proceeded to divest herself of her surplus clothes, including the coat. When, after being picked up at sea, she was asked to what she attributed her survival, she replied: "Just typical Brown luck. I'm unsinkable."

"CRIPES! MY BACKFILL TAMPER!"

As Fowler recites, when a girl of fifteen, the future Mrs. Brown ran away from her parent's shanty on the mud flats at Hannibal, Mo., and landed in the then vigorous mining camp of Leadville, Colo. Three weeks later she was married to "Leadville Johnny Brown." Soon after the wedding her husband struck gold and sold his claim for $300,000 cash. He received payment in $1,000 bills and took the money home to his wife.

"It's all yours," he told her, "but you've got to hide it where it will be safe." Then he sought the local saloons to celebrate. His wife, Molly, hid the money all right—in the stove. Long after she was in bed, her husband rolled home with a couple of pals and, feeling chilly, kindled a fire in the stove. Next morning, when he was sober, he learned what it had cost him to get warm. He only laughed at the news of his loss.

"Lots of men would get mad," said Molly. "It just goes to show how much I think of you," was Johnny's reply. "There's plenty more."

And, in true story-book fashion, Brown went out and located "The Little Jonny," which became one of the greatest gold mines in Colorado. It is estimated that he took $20,000,000 from it. Mrs. Brown dispensed much of this fortune for charitable purposes.

* * *

Putting Dobbin to Work Again

CARLOADINGS and steel output have their acknowledged places as indices of the economic trend of the times, but how about the production of horseshoe nails? When dobbin goes back on the job he must be shod, so it seems to us that there is a ray of sunshine in the fact that the demand for horseshoe nails is on the upgrade.

The Government census of manufacturers discloses that the output jumped from 43,900 kegs of 100 pounds each in 1931 to 57,915 kegs in 1933. The indicated gain of 32 per cent cannot be ignored. Probably some of the horses now wearing these nails were reconditioned to plow cotton under the ground, but even that destruction of a source of natural wealth has been duly prescribed by the official medicine men as a partial curative for one of Uncle Sam's numerous aches. By and large, the increased horse power must be working on farms, road jobs, and in other lines of effort at tasks concerning whose beneficial effects there can be no argument.

The horseshoe-nail census goes back to 1927, when 111,045 kegs were produced. By 1929 the output had fallen off some 17,000 kegs. The average price per keg dropped from $14.40 in 1927 to $10.30 in 1933. The census reveals the interesting fact that all the country's horseshoe-nail production during the past seven years has come from three establishments.

Reaching 240 Miles Across a Desert for Water

Work on the Colossal Colorado River Aqueduct to Southern California Well Underway

LAWRENCE A. LUTHER

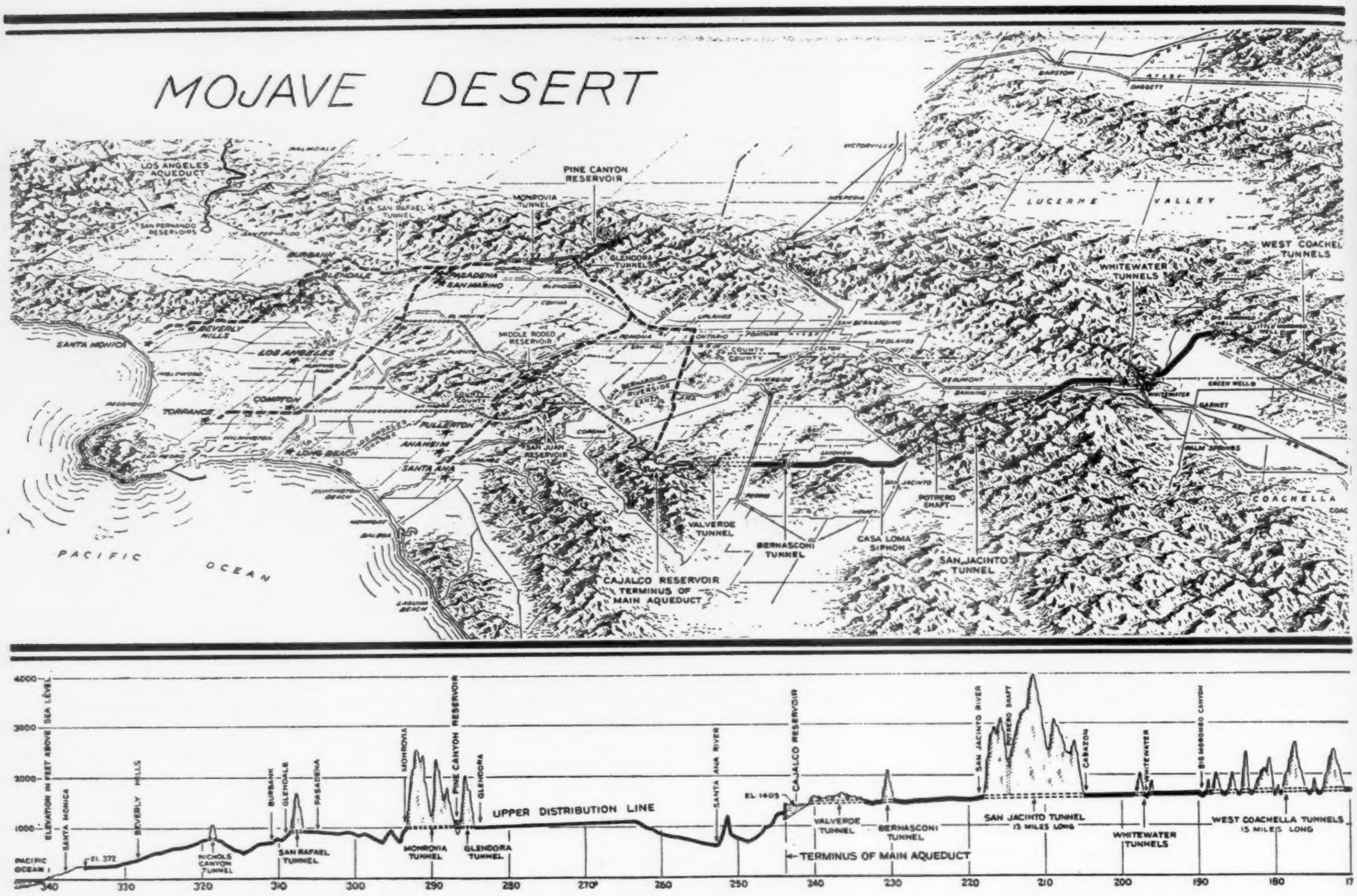
DIAMOND DRILLING AT PARKER DAM SITE

At this point on the Colorado River, 155 miles downstream from Boulder Dam, a concrete arch-gravity-type dam will be erected to divert water into the aqueduct. The crest of this structure will be 330 feet above bedrock, and the river level behind it will be raised 72 feet. The estimated cost of the dam is $13,500,000. The span between solid rock walls at the dam site is 340 feet.

MIGRATION of more than 1,000,000 people to Southern California since the turn of the century has transformed its dreamy Spanish villages and proved its climatic lure to be not less potent than that of Florida or the French Riviera. Never before has an area so recently desert supported so vast a population; for, though this southern end of the state comprises half its population and wealth, it was endowed with less than 1 per cent of its water resources. Developing adequate supplies apace with this rapid influx of seekers after sunshine and opportunity has never been an easy task. Rainfall in the watersheds of the Southwest, like all sections receiving more or less scant precipitation, is highly erratic; and charted records of extra dry cycles indicate that they frequently extend over periods of several years.

One of these subnormal cycles is now being experienced, and the reserve supply—represented by ground-water level throughout the area affected—is being overdrawn continually. The fact that the 275-mile Owens River Aqueduct, completed by William Mulholland in 1913, is used to capacity, and that little of that watershed remains to be developed, has turned the attention of Los Angeles engineers to the Colorado River. Estimates of the work essential to any permanently adequate development, and recognition of the problem as being one common to all communities, resulted in the organization of the Metropolitan Water District of Southern California, an affiliation of twelve other municipalities in Los Angeles and Orange counties effected in 1927 for the purpose of engineering and financing an aqueduct to the Colorado or to some other adequate source. Conscious that it was charged to handle one of the largest long-time investments ever to be made for the supply of water, that most vital of public works, the Metropolitan Water District staff undertook exhaustive studies covering more than 100 routes to the Colorado, weighing carefully the advantages of every line suggested. Typical of its open-minded attitude was the investigation of an 850-mile aqueduct proposed for tapping the watershed of the San Juan River in the northern part of New Mexico.

The earliest surveys date from 1923, and intensive geological reconnaissance was begun in December of 1929. The fact that the geologic architecture of our Pacific states is more in transition than are the relatively stable eastern areas influenced to a considerable degree the route chosen: the crossing or paralleling of active or dormant faults—the expansion joints of a continent—had to be carefully engineered.



RELIEF AND PROFILE SKETCHES OF AQUEDUCT

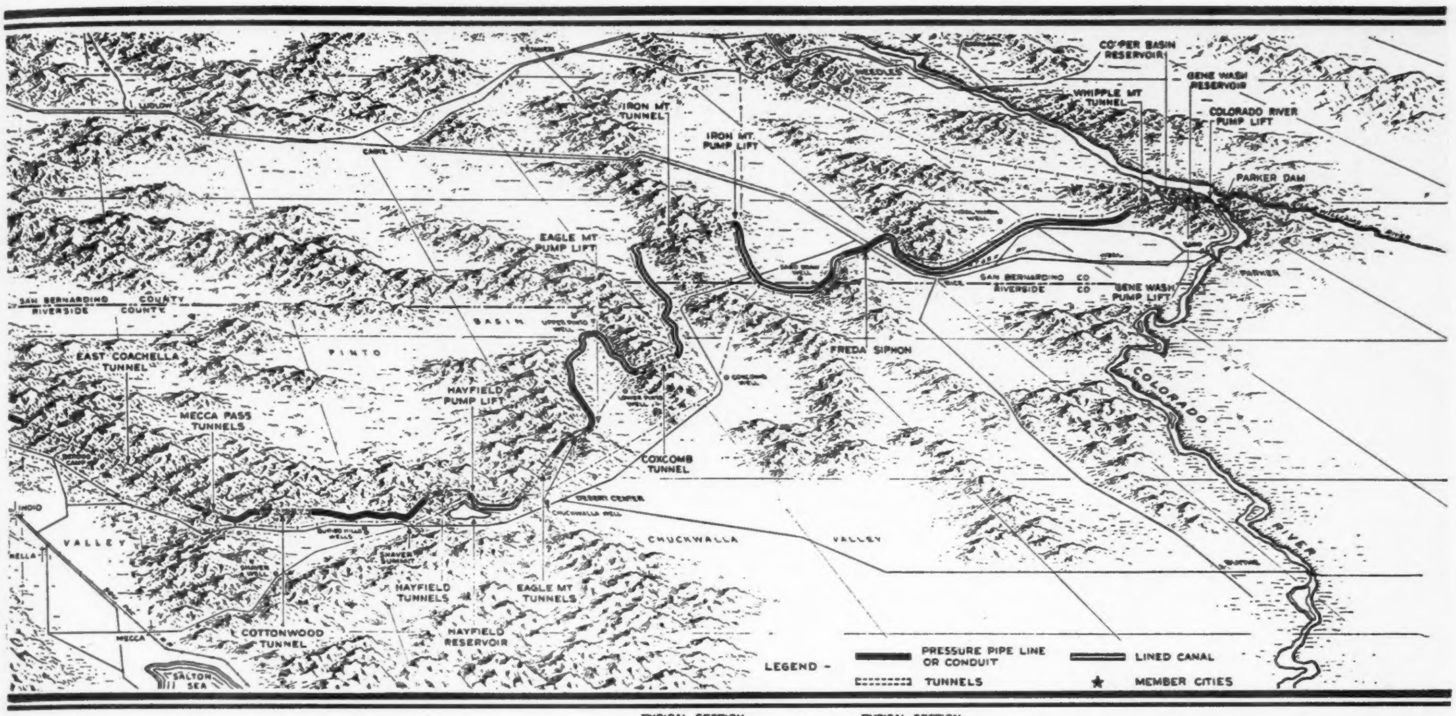
Nearly 1,000,000,000 gallons of water daily will be carried by this 241-mile conduit to thirteen cities, in Southern California, comprising the Metropolitan Water District. To effect a crossing of the mountains, it will be elevated 1,616 feet in five pumping lifts. Power for this purpose will be supplied principally from Boulder Dam. For 90 miles of its course, the aqueduct will be in tunnels.

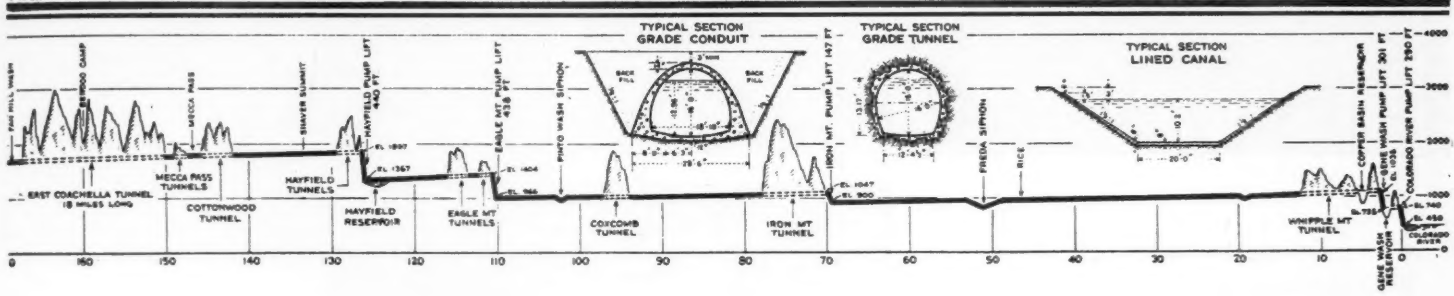
The areas to be traversed were largely wilderness, with little data available concerning rock structure; and long and deep tunneling through formations apt to prove unstable, water-bearing, or so heavy as to require excessive timbering, was avoided. To permit contractors to bid intelligently, analyses of materials to be excavated had to be reasonably comprehensive; and the ground encountered in tunnels driven to date on the several contracts has tended largely to substantiate the original data supplied. The selected route, which taps the Colorado 58 miles below Needles, Calif., and eighteen miles above Parker, Ariz., will not only assure an adequate supply from a well-nigh inexhaustible source but give the urban and agricultural communities of the coastal basin triple insurance against any water famine incident to storms, sabotage, or to seismic disturbance which might destroy one or the other source—they will draw their water from the Owens River, the Colorado, and the ground.

The right of the district to divert the required flow from the Colorado River was contingent upon storage of flood waters through the construction of Boulder Dam. So, along with the use of hydro-electric power by the City of Los Angeles, the Metropolitan Aqueduct became an integral part—in fact, was essential to Federal approval and financing—of the Boulder Dam Project. The completed aqueduct, with facilities for distribution, is estimated to cost approximately twice as much as Boulder Dam, or $220,000,000; and something over $5,000,000 already has been spent for accessory facilities such as surfaced highways, 450 miles of electrical transmission line, nearly 200 miles of water line to supply camps, and living quarters and shops for 31 camps. The aqueduct proper is to have a total length of 241 miles, and is to be carried through tunnels for a distance of 91 miles. To finance this latter phase of construction over a 2-year period, the Reconstruction Finance Corporation is periodically purchasing, to an aggregate amount of $40,000,000, blocks of the $220,000,000 bond issue voted by the constituent cities of the Metropolitan Water District in 1931.

The terrain to be traversed is exceedingly rugged, is little populated, and is characterized by a combination of aridity and high temperatures unsurpassed on this continent. These circumstances have made it more than usually easy to procure the right of way, but they have complicated the problem of access roads and living facilities. Approximately $1,000,000 is being spent in grading and oil-surfacing 172 miles of construction roads, which are now largely completed. This work was contracted to various western firms. The roads have an average width of 20 feet, and all but mountain sections have a 6 per cent maximum grade and a minimum radius of 2,000 feet on curves. Timber bridges, corrugated-iron culverts, and dips are used to cross desert washes, dips being laid out with easy slopes and provided with 3-foot cut-off walls on upstream sides so as to prevent scouring.

The greater part of the grading was done with Caterpillar tractors and various types of bulldozers and scrapers, with some drilling and shooting for excavating with power shovels in mountain territory. Where native materials were found unsuitable for surfacing, selected bank-run gravels were hauled, crushing and screening plants being employed in certain instances to reduce haulage. A 65-70 grade of road oil was utilized for the 3-inch minimum wearing surface and was applied and mixed in the conventional manner by spraying and blading in windrows with an ingenious road-mix machine devised by C. W. Wood, Stockton, Calif. These units, which were employed on 100 miles of road, gather



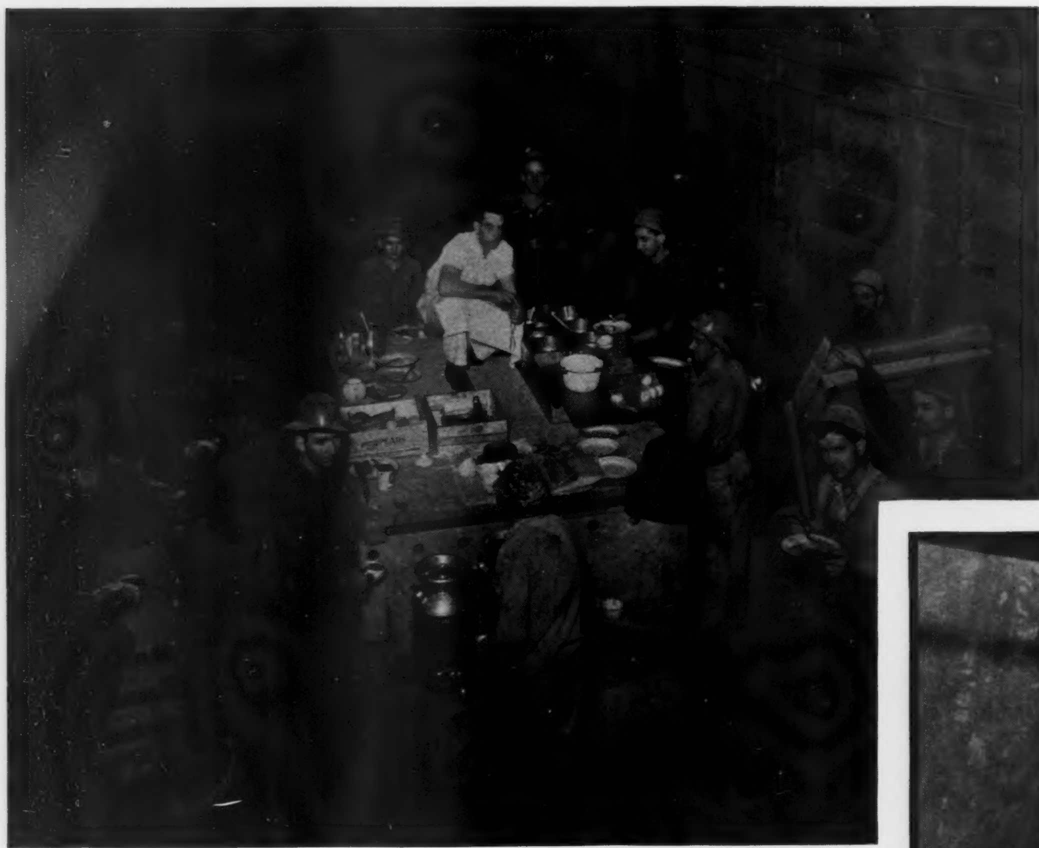


material from 2-foot windrows, apply oil under pressure, and effect mixing with a series of knives—an oil-fired furnace serving to hasten absorption. Three auto patrols are used by the Metropolitan Water District in maintaining these roads, which, incidentally, are making a large area accessible to the motoring public.

As Boulder Dam begins to function, a diversion dam will be constructed at the site chosen north of Parker by the U. S. Bureau of Reclamation and under contract with the Metropolitan Water District. A grant of $2,000,000 has been secured from the Federal Public Works Administration partly to finance the building of this dam, a tentative design of which calls for a structure of arched-gravity type. Borings have disclosed solid rock for footings at a depth of 185 feet; and the $13,500,000 dam contemplated will rise 330 feet from its footings and will impound water to a depth of 72 feet above river level. Canyon walls of sound rock are 340 feet apart at the dam site, and the dam will be 740 feet across at its crest. Storage capacity will amount to 717,000 acre-feet; and a hydro-electric plant of 80,000-kw. capacity, supplied by two intake towers and two 40-foot and six 18-foot penstocks, is a feature of the completed design. Half of this power will be available for use by the District. Stream diversion during construction will be handled by cofferdams and by diversion tunnels somewhat similar to those employed at Boulder Dam; but the use of that great structure in regulating stream flow will simplify and protect operations on this project, which will be situated some 155 miles below.

The pumping of 969,000,000 gallons of water daily over the five lifts in the aqueduct line will write a new chapter in hydraulics. The initial lift at the river will raise the water 290 feet from reservoir elevation 450 to the 5,640-foot Colorado Tunnel, from which it will discharge at elevation 735 into Gene Wash Reservoir. A second plant, designated as the Gene Wash Lift, will raise the water 301 feet to elevation 1,036, discharge into Copper Basin Tunnels Nos. 1 and 2, which have an aggregate length of 12,280 feet, and deliver to Copper Basin Reservoir. This reservoir lies at tunnel elevation between Copper Basin Tunnel No. 2 and the 32,190-foot Whipple Mountain Tunnel. From the west portal of the latter tunnel the water will be carried some 65 miles in siphons and open canal to Iron Mountain Pump Lift, where it will be raised 147 feet from elevation 900 and delivered to the 39,805-foot Iron Mountain Tunnel. By canal and pressure line it will be conveyed from the west portal of this tunnel about 40 miles, including the 17,530-foot Coxcomb Tunnel, to a pump lift at Eagle Mountain, where it will be raised from elevation 966 to elevation 1,404 and delivered to East and West Eagle Mountain tunnels. These have an aggregate length of 35,778 feet and are separated by approximately two miles of canal. From the west portal of West Eagle Mountain Tunnel it will flow through a canal some 10 miles to the 90,000-acre-foot Hayfield Reservoir. Here the final and highest lift, 440 feet, will be made to the east portal of Hayfield No. 1 Tunnel at elevation 1,807—the system continuing approximately 24 miles through six tunnels and intervening canals to the 18-mile-long East Coachella Tunnel. Eleven tunnels, ranging in length from 3.2 miles to 790 feet, and two major siphons lie between the west portal of East Coachella and the scenic San Jacinto Range, which is penetrated by the second longest tunnel—the 13-mile San Jacinto. Two more tunnels, the Bernasconi, 6,220 feet, and the Valverde, 37,150 feet, are included in the 20-mile conduit between the west San Jacinto portal and Cajalco Reservoir, which lies at elevation 1,405.

Various tentative designs have been made of distribution systems to be used west of this terminal reservoir; and storage facilities will include Pasadena's recently completed dam in Pine Canyon. Power development may be a feature of the plan west of Cajalco. Field and laboratory experimental work is in progress in connection with desilting facilities, pumping plants, and the precast and monolithic construction for the 150 siphons required. Aqueduct tunnels are to be 16 feet in



LUNCH UNDERGROUND

An electric haulage locomotive (left) makes a good substitute for a table in the West Eagle Mountain Tunnel, which is being driven by L. E. Dixon and Bent Brothers. It will be noted that the chef is in a strategic position to dispense the food, which reaches the men in a hot and appetizing condition. As is the case at Boulder Dam, everything is done to make the lot of the workmen as comfortable as possible in the face of the limitations Nature has imposed upon the sparsely settled section through which the aqueduct is being built.

COMPRESSORS AND DRILL

At Whipple Mountain, the two belt-driven compressors shown here (right) supply 3,000 cfm. of compressed air, and an oil-engine-driven unit serves as a standby. Drilling is done with Auto-feed drills of the type pictured. These feed the drill steel against the rock face automatically, the impulse being supplied by harnessing the recoil. Numerous advantages result, and this innovation is one of various improvements in drilling equipment which are making rapid progress possible.

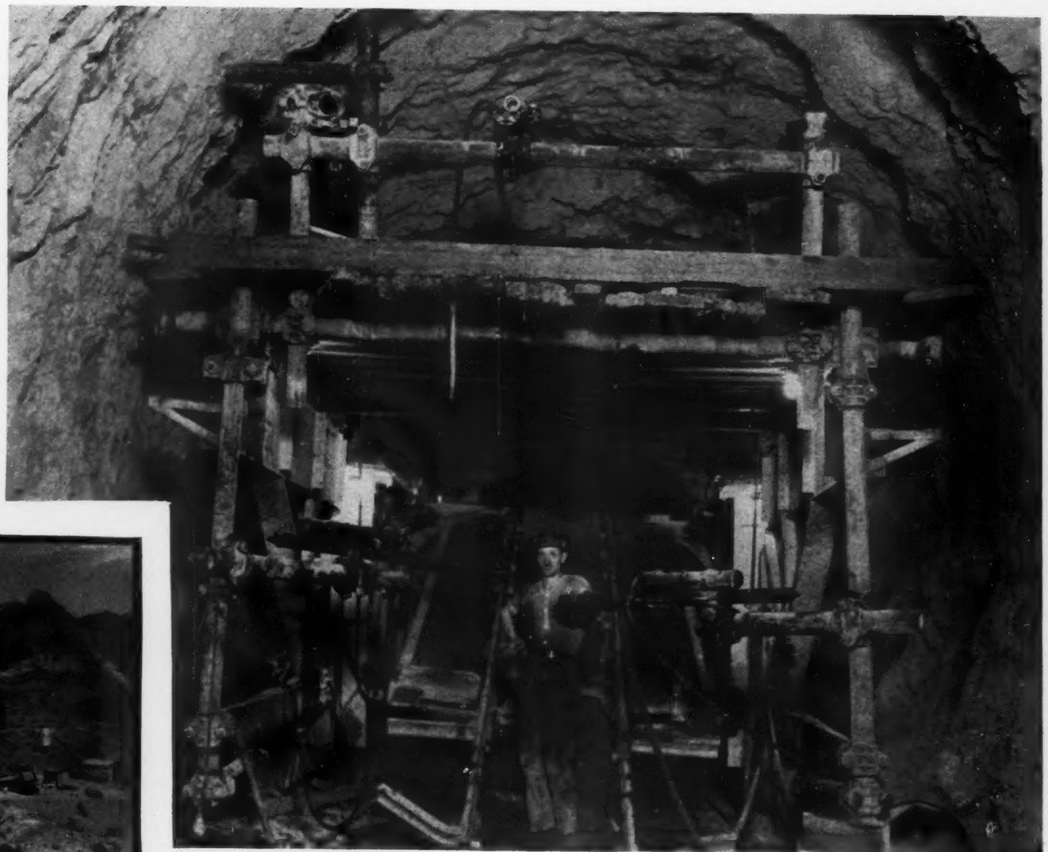
diameter, of horseshoe shape, and will be lined throughout with 1 foot of concrete. Contracts covering 58 miles of tunnel have been let to fourteen contracting firms, while 33 miles, including the 18-mile East Coachella bore, are being driven on force account by the Metropolitan Water District. Thirty-one camps have been established, and many headings are being advanced with unexampled speed. Competition between camps for high daily and monthly footage has influenced progress to a marked degree since the first headings were opened—teamwork with respect to footage, excellence of finished bore, and the camps' safety records being evident everywhere. Some 5,000 men are now employed on the project, and it is expected that this number will be increased to 15,000 when peak operations are reached.

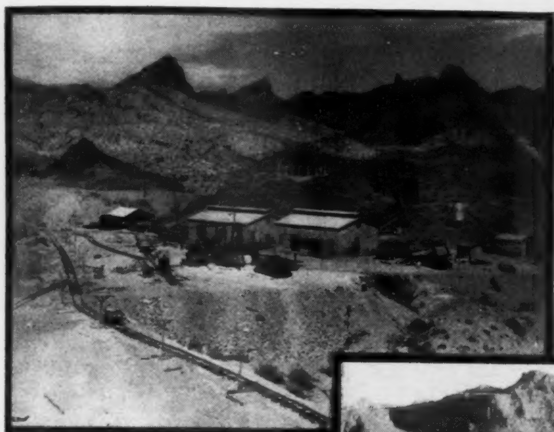
The most modern tunnel-driving equipment is being utilized; and, with contractors striving further to improve the technique of drilling rock and handling muck, numerous innovations have appeared in machines employed. Methods and equipment being used on the contract held by Walsh Construction Company, Davenport, Iowa, are typical. This contract, awarded on a bid of $4,357,780, covers the driving of 9½ miles of tunnels through four separate peaks or ranges, the longest—32,190 feet—being through the Whipple Mountains. These tunnels are located on the intake end of the aqueduct and include the Colorado River and Copper Basin bores. Six miles of oil-surfaced highway connecting with the Parker Dam-Earp Road along the river were subcontracted to A. Teichert & Son, Inc., Sacramento, Calif. The Town of Earp, which was named for Sheriff Earp—an outlaw-hunter extraordinary in the Southwest during the eighties—is located on the Cadiz-Phoenix line of the Santa Fe Railway.

A main camp has been established 0.86 mile west of the central point on the Whipple Mountain bore. It includes living quarters, a mess hall, and a building housing offices and attractive guest rooms. There is also a field hospital, staffed by a doctor and an interne, that is well equipped with X-ray, sterilizer, and other apparatus for handling all cases except compound fractures and major operations, which are sent to Los Angeles. Other facilities include a storehouse and a blacksmith and general repair shop provided with a repair bench and test-mounting for drills and with two No. 50 I-R sharpeners and two No. 26 oil furnaces for sharpening and shanking the 1¼-inch bayonet-shanked drill steel used. A 4-K shank grinder serves in truing shanks and in dressing striking faces of drill pistons. Compressor equipment at this camp consists of two 1,500-cfm., Ingersoll-Rand XCB-2 machines and of one POC-2 oil-engine-driven standby under a separate shelter house. Current for operating the compressors and blowers and for haulage is delivered to the camp over a construction power line provided by the District.

"KING GRASSHOPPER"

This is one of several machines devised to facilitate drilling and mucking operations. It is used by Walsh Construction Company in the Whipple Mountain Tunnel. It consists of a drill carriage on which five N-75 Auto-feed drills are mounted, and of an upper level over which empty muck cars are moved into position at the breast. This view (right) shows the forward end with the ramp connecting with the upper level. This, and a similar incline at the rear, are raised when it is desired to move loaded muck cars back along the tracks at tunnel-floor level.





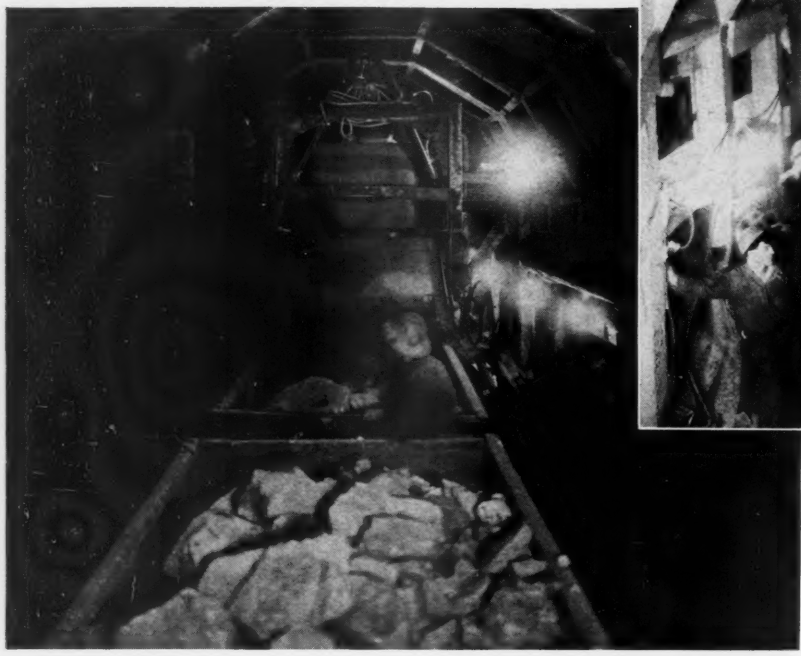
TYPICAL TOPOGRAPHY

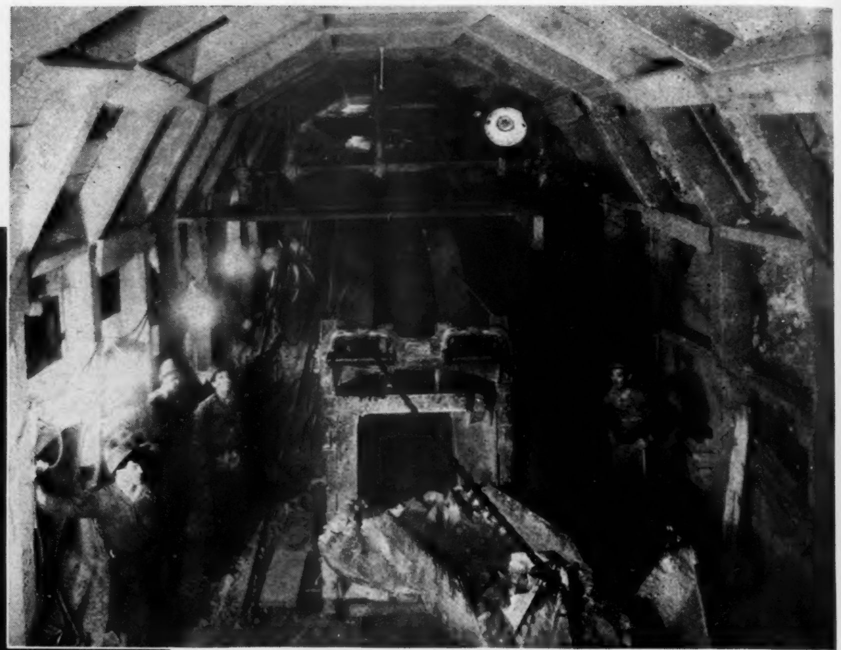
The terrain being traversed is alternately serrated peaks and desert sinks. The region is an arid one, and summer temperatures are the highest experienced in the United States. Adjoining this legend is shown a stretch of excellent construction highway along the Colorado River near the Parker Dam site. The other small view shows the compressor house and steel shop of Walsh Construction Company near the entrance to the adit through which this firm is excavating the Whipple Mountain Tunnel.

A 12x14-foot adit was driven for 1,020 feet to the tunnel line, and both east and west headings were opened through adit connecting chambers on 75-foot radius curves with an intervening rock pillar. Ventilation is provided by two Roots-Connersville 5,000-cfm. blowers, operating on suction through a 22-inch steel line, and by two semiportable blower units, one near each heading, delivering air to the headings through fabric tubes. The tubing is built up periodically and the blowers are moved up as driving progresses. Unusually good ventilation is assured by this set-up, the tunnel being one of the cleanest on the line. Six-inch air lines to each heading carry 110-pound air, and 3-inch lines supply water. Haulage is by 11-ton Goodwin locomotives, designed for dual trolley and storage-battery operation, and by 5-yard Western cars. Tracks are of 40-pound rail and 3-foot gauge. They are laid on the center line of the tunnel and have double-track sections to enable passing.

Alternate operation of one shift on the two headings being advanced from the adit—that is, drilling at one heading while mucking at the other—has been found to be a highly satisfactory method with respect to progress, economy, and working conditions for the men. Drilling and car-transfer operations at both headings in this tunnel are carried on from a "King Grasshopper". From the lay standpoint this may be described as a 28½-ton steel framework, 122 feet long, mounted on double-flanged steel wheels and carried forward on track of 10-foot gauge. The front end serves as a jumbo for mounting drills; and central clearance is sufficient to permit passage of loaded cars or the No. 60 Conway mucking machine employed. Movable ramps at both forward and rear ends give access to an upper deck and thus provide a double-deck passing track over which empty cars may be switched into position under the belt conveyor of the mucking machine while full cars are drawn back on the lower track. Air cylinders of 10-inch and 8-inch size are used to raise and to lower the ramps; strings of empties are pushed up with a locomotive; and an HU air hoist is employed in lowering individual cars into position for loading.

Rock encountered to date has been fairly hard granitic gneiss, and little timbering has been required. Thirty Auto-feed I-R drifters of the N-75 type have been provided for use at the Whipple Mountain and Copper Basin camps, five being mounted on each of the four jumbos. The feed employed on these drills is simple and requires no auxiliary power, normal recoil being harnessed to the task of rapidly driving the drill backward or forward or holding it with uniform pressure against the drill steel by a set of ratchets governing the rotation of a conventional feed screw. Reduced clearance permits better placing of holes; and relieving drill runners of the labor of hand cranking has effected quicker steel changes, prompt correction of wrong alignment, and has lessened the wear and tear on





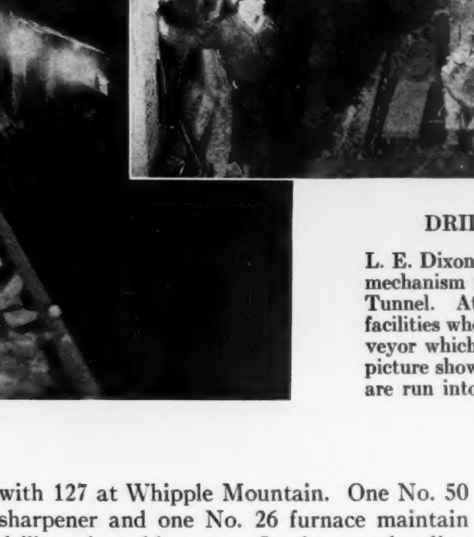
DRILL CARRIAGE AND MUCK HANDLER

L. E. Dixon and Bent Brothers have rigged up this ingenious mechanism for speeding operations in their Eagle Mountain Tunnel. At the front (above) is a drill carriage, and also facilities whereby a Conway mucker dumps spoils on to a conveyor which runs back through the carriage. The left-hand picture shows this conveyor discharging muck into cars which are run into position beneath its rear end.

the men. This innovation in drilling practice has, with other improvements in tunneling equipment, contributed measurably to the rapid advance being registered on several contracts, and might properly be said to have set another precedent in man's mastery of his topographical barriers. Approximately four hours is consumed in drilling an 11-foot round of 42 holes, including four 13-foot cut holes. Hercules 40 per cent gelatine dynamite is employed in all but cut holes, in which 60 per cent is used; and the average consumption of explosives to date has been approximately 2¾ pounds per yard. Rock broken at each round has averaged 28 cars, and 3½ hours is spent in mucking.

The Whipple Mountain Tunnel will be driven entirely from the adit. A 114-foot-deep, 4x6-foot ventilating shaft has been sunk to the tunnel line at Barometer Wash, and a 15,000-cubic-yard open-cut excavation has been made for the construction of the east portal and gate structure. The Walsh Construction Company has established a second camp at Copper Basin, 8,290 feet from the Colorado intake, and is advancing two headings in the Copper Basin bore from a 613-foot adit. The general procedure is similar to that employed in the Whipple Mountains; and, as on that job, the entire tunnel will be driven from the adit without opening the portals, which will be 9,700 feet to the west and 1,900 feet to the east.

Camp equipment at Copper Basin is somewhat less elaborate than at headquarters camp, 95 men being employed as compared with 127 at Whipple Mountain. One No. 50 sharpener and one No. 26 furnace maintain drill steel at this camp. In the west heading of this tunnel a cherry-picker is used to transfer cars in place of the larger apparatus employed in other headings. Mounted on 10-foot-gauge rails much like the King Grasshopper, this is a relatively short jumbo provided with tackle for raising an empty car



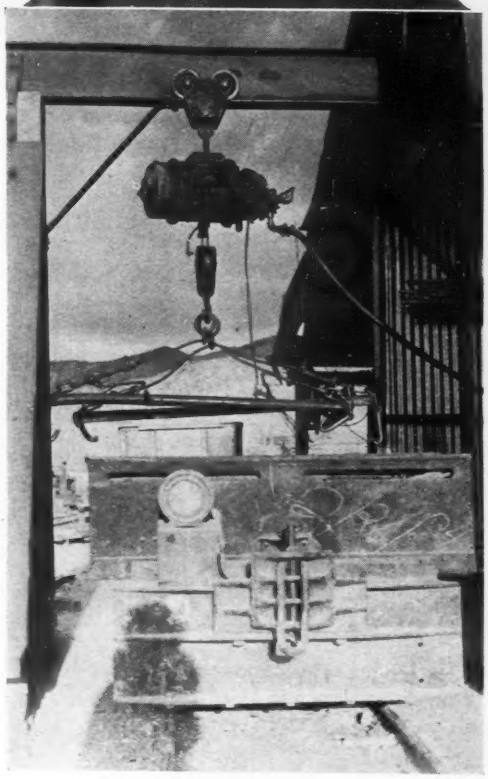
DRILLING ROUND

This diagram shows how holes are placed in the Whipple Mountain Tunnel, together with their order of firing. The round consists of 46 holes.

sufficiently to permit a load to pass beneath. Water encountered thus far in either tunnel has been confined to very light seepage, and has been handled, along with periodic accumulation of water supplied to drills, by a No. 25 I-R sump pump. In the Whipple Mountain bore water is pumped into a tank mounted on a car, while the pump used at Copper Basin delivers through a line 2 inches in diameter.

Copper Basin Tunnel No. 1, a 750-foot tunnel lying 500 feet east of Copper Basin No. 2, will be driven from its west portal. The 5,460-foot Colorado River Tunnel, which lies one mile east of Copper Basin No. 1, also will be driven entirely from its west portal. Total footage made at each pair of headings in the two tunnels now underway averages around 250 per week. The contract calls for their completion by July, 1938; and the total advance made up to May 31, 1934—Whipple Mountain, 6,340 feet, Copper Basin, 5,378 feet—indicates that the work is well ahead of schedule. J. H. Gill is Pacific Coast manager for Walsh Construction Company; Floyd T. Huntington is general superintendent on the aqueduct tunnels; and C. H. MacLeod is office manager.

A somewhat different general practice characterizes the $1,699,705 contract held by Utah Construction Company, Salt Lake City, for driving 16,172 feet of tunnel through the Iron Mountains. Here a heading was opened at the west portal, some 78 miles from the Colorado intake, from a 611-foot cut on a 10 per cent incline. Cars are pulled up this



USES OF COMPRESSED AIR

In addition to operating the drills, compressed air sharpens the steels and also serves many other needs. The 4K shank grinder is of invaluable aid in truing drill-steel shanks and drill pistons. The one pictured above is in the Copper Basin Camp of Walsh Construction Company. Seepage water in several of the tunnels is handled by No. 25 sump pumps, such as the one shown at the upper right. A Size D air-motor hoist is pictured at the lower right in the act of lifting batteries, that are in need of charging, from an electric locomotive at the Iron Mountain Camp of Utah Construction Company.

earth ramp by a 150-hp. Thomas hoist. The tunnel is double tracked throughout, a cherry-picker being used near the face to transfer cars. A Plymouth gasoline dinkey hauls cars on the dump, and 6-ton Baldwin-Westinghouse battery locomotives serve between the incline and the face. Air is supplied by a 20&12x16 and a 19&12x16 Ingersoll-Rand XB compressor, while a No. 50 I-R drill-steel sharpener and a No. 26 furnace are employed in conditioning steel. Six RB-12 "Jackhamers" and six No. 73 clay diggers are provided for use in soft formations. The fact that 6,470 feet of tunnel has been driven up to May 31, 1934, indicates that the contract should be completed considerably ahead of the specified date, December, 1938. H. J. Lawlor is general manager for Utah Construction Company, and Ben Arp is tunnel superintendent.

An ingenious and somewhat spectacular muck-handling apparatus is in service on the $1,025,898 contract held by L. E. Dixon Company and Bent Brothers, Inc., Los Angeles, for driving 10,649 feet of tunnel through the western portion of Eagle Mountains. This consists essentially of a 138-foot-long jumbo that moves on 9-foot-gauge track and carries a 36-inch-wide belt conveyor. A No. 60 Conway mucker delivers to the forward end of this belt, the length of the jumbo being sufficient to permit a train of empty cars to be successively spotted for loading beneath the chute at its outer end. With it it is possible to handle the 40 yards of muck required to load a train in about fifteen minutes. A 35-hp. variable-speed motor supplies power to the belt, which travels on rollers of conventional design. Seven N-75 drifters are mounted on this combined jumbo and conveyor; and a round of forty-four 7- to 11-foot holes—depth depending upon character of ground—is drilled and shot, on an average, in 2½ hours. Rock encountered thus far has been granite of varying hardness.

This tunnel is officially known as Eagle Mountain No. 2, and is being driven from the west portal located approximately 115 miles from the intake. Haulage is by two 9-ton General Electric battery locomotives and 5-yard Koppel steel cars. The contract is scheduled for completion in December, 1938; and the total footage made up to May 31, 1934—4,488 feet—indicates this work to be well ahead of schedule. L. E. Dixon is general manager on this contract; Paul Gwinn is tunnel superintendent; and C. H. Bent is superintendent in charge of outside facilities. It is impossible in one issue to give more than a brief outline of the interesting methods employed on a few of the many contract and force-account jobs.

The thirteen cities included in the Metropolitan Water District are Anaheim, Beverly Hills, Burbank, Compton, Fullerton, Glendale, Long Beach, Los Angeles, Pasadena, San Marino, Santa Ana, Santa Monica, and Torrance. Utilization by individual cities of the water made available will be in proportion to the financial burden borne by each. Each municipality is guaranteed complete autonomy so far as methods used to finance the undertaking are concerned, and is free to raise funds by tax levies, through water rates, or by a combination of both. Directors are elected from each municipality to sit on the District board; and F. E. Weymouth is general manager and chief engineer. The project is scheduled for completion in 1939. A general construction headquarters has been established at Banning, Calif., with three divisional headquarters located along the aqueduct line.

EDITORIAL

ANOTHER INDUSTRIAL HURDLE

DESPITE the fact that there are admittedly at least 9,000,000 jobless persons in the United States, an actual shortage of skilled mechanics exists in some sections. Some machinery manufacturers that have enjoyed an upswing in business during the past six months already have reëmployed all the available qualified men who were on their payrolls in 1929 and have now actually reached a stage where they are obliged to train green men for specific machine operations.

This anomalous condition results, of course, from the depression. Some of the former employees have found jobs in other lines of work, others have moved to different localities, and still others have died or have become incapacitated from one cause or another. Primarily, however, the shortage of trained workers is attributable to the fact that for more than four years practically no apprentices have been employed. The situation is now complicated by code requirements. In the heavy-machinery manufacturing field, at least, the absorption of increased operating costs has brought about a situation where a considerably increased volume of sales will be required before the training of a new crop of skilled workers can proceed on a basis that will insure a continual supply of capable men.

This condition is unfortunate for both companies and individuals. As matters now stand, men who are total strangers to machine shops are being trained for a week or two in the handling of a particular operation and then put to work. They will become capable men at their specific tasks, but their lack of a general course of instruction such as an apprenticeship affords will handicap them in their chances of advancement. Their employers will suffer, in turn, from not having flexible organizations. In thê construction trades, which have been at an especially low ebb in recent years, the same influences have been at work, and the pick-up in activities which the Government is now fostering is bound to uncover a shortage of expert workmen in a surprisingly brief time.

HIGH-SPEED PHOTOGRAPHY

A GERMAN engineer has developed a motion-picture camera which will take 6,000 pictures a second and which, by reducing the size of each frame, can be made to record as many as 80,000 exposures a second. The camera is expected to be useful in many ways, and particularly in furthering engineering studies. Many actions, which are now little understood because there has been no way of definitely checking what takes place when they occur, can now be followed closely in slow-motion images.

Research engineers may revolve flywheels at speeds that cause them to burst, and determine just what happens. The result will be better and safer flywheels. Vibration of rapidly rotating shafts may likewise be scrutinized and an annoying trouble lessened. These are only two of the myriads of technical problems that may be solved with the aid of this remarkable new photographic instrument.

The speed limit of the new camera when making ordinary-size pictures is 250 exposures a minute, and as the number of pictures increases above that figure their size diminishes. At its extreme speed it takes virtually a continuous view, and a normal-size frame contains about 110 exposures. Since it is impossible to open and close a shutter as fast as this camera calls for, that detail is handled by means of a rotating element containing a lens. As this passes a fixed lens, the image is recorded.

The camera holds 262 feet of film, which is enough for only 4 seconds' run when making an average technical film. Because of the high speed at which the film flows through the machine, no attempt is made to wind it on a reel after exposure. Instead, it is run into a lightproof bag that is fastened to the underside of the camera.

MINERALS OF DEFENSE

IN VIEW of the fact that the natural resources of the United States are popularly supposed to be boundless, it may come as a surprise to many persons to know that in the event of a war upon us, and the establishment of an embargo, we should be unable to secure a number of products which are considered vital to national defense.

Writing in *The Military Engineer*, Maj. G. A. Roush comments: "Try to picture a war program of munition production without manganese to dioxidize steel; without nickel and chromium for alloy steels; without tungsten for tool steels; without antimony for shrapnel and primers; without quicksilver for detonators; without natural nitrates for powder; and without the platinum necessary to make nitrates synthetically, as well as for the manufacture of the sulphuric acid needed in the various processes in the making of explosives. Tin, mica, and iodine are badly needed for other purposes, but the eight materials mentioned are absolute necessities in the development of any modern program of munition manufacture, and deprived of them, properly defending ourselves in any way against a nation not equally handicapped would be an impossibility, for we would be reduced almost to the level of the savage from the standpoint of weapons. Our great supplies of coal and petroleum, iron and copper, lead and zinc, would be next to worthless, for without these comparatively minor products, we would be hopelessly handicapped."

Although Major Roush is taking the worst view of the situation, there is undoubtedly food for thought in what he says. We have plenty of tungsten in Colorado, Nevada, and California. Production of it lags because foreign tungsten can undersell it. One western mine contains a large part of the known molybdenum of the world, and this metal is an excellent substitute for nickel. Arkansas, California, and other states probably could develop quicksilver sufficient for our needs if pressed. Adequate facilities for producing synthetic nitrates could be made available in relatively quick time. Thus the picture is not so black as it has been painted by the militarists, but it warrants sober consideration just the same.

AERIAL SURVEYING PROGRESSES

OUR May issue contains an article describing some of the many engineering purposes for which aerial photography is being used. As showing the trend towards its constantly expanding service in this direction, it is of interest that the British have just approved carrying on a large-scale city-planning project by this method. An area of 16,000,000 acres is involved, and the decision to take to the air was made to speed up the work. Although the prevalence of fog reduces the normal expectancy of favorable flying weather to about 30 days in the course of a year, it is expected that this will suffice for the completion of the photography in two years.

Four years ago the Ordnance Survey prepared city-development plans for this entire area. By making aerial photographs to the same scale as these existing plans, reproducing them on transparent bases, and superimposing them on the ground map, it will be possible to note at once new buildings, roads, and other structures. It will then be a simple matter to include these additions on the older map, or to prepare a new one combining the information furnished by the ground and aerial maps. For some time, the Ordnance Survey has been using aerial surveying for examinations preliminary to ground work, and its further recognition of the method is considered an important forward step in the science of air mapping.

CLARKE A. BURGESS

CLARKE A. BURGESS, a retired veteran machinery salesman known to many users of compressed-air equipment throughout the eastern portion of the United States, died May 5 at his home in Toms River, N. J. He was 67 years old.

For a number of years prior to 1922, Mr. Burgess represented Ingersoll-Rand Company and one of its predecessor concerns, Ingersoll-Sergeant Drill Company, having been attached at different times to four branch sales offices.

Early in life Mr. Burgess displayed qualities which presaged a career in salesmanship, and he developed them to a degree which won him an enviable reputation in his chosen work. When he was a boy of nine in Marathon, Cortland County, N. Y., he was obliged to go to work following the death of his father to help support the remaining family consisting of his mother, two sisters, and himself. He obtained employment in a local tannery, and proved so adept at the work that within a few years he was contributing materially to the family budget.

His industry, loyalty, and good nature attracted Oscar Pinckney, president of the Climax Road Machine Company which was also located in Marathon. Mr. Pinckney gave young Burgess a job and started training him for selling work. As a result, Mr. Burgess was "put on the road" soon after he had attained his majority, and almost immediately began to turn in a sizable volume of business.

During this period he married Miss Belinda Johnson, daughter of a farmer in the Marathon area. Some ten years later, Mr. Burgess took a position with the Ingersoll-Sergeant Drill Company, maker of rock drills, compressors, and allied equipment. He was assigned a territory centering on Cincinnati, but was working under the jurisdiction of the branch office in Cleveland.

All the while he was gaining valuable experience, and was already known as an expert in his line. A keen judge of human nature, he had the knack of quickly ingratiating himself with his prospective customers. His son, who supplied the information for these notes, states that as far back as he can remember, his father had a habit of sitting at a typewriter until late at night patiently punching out letters to his clientele. He made these individual, each one designed to appeal to the man that received it, and they were liberally sprinkled with the lusty, salty humor for which he was known.

CLARKE A. BURGESS

From Cleveland, Mr. Burgess was transferred to Chicago. There, over a course of years, he maintained his record for effectiveness, and, after a time, he was moved to New York. It was in this latter place that he attained his greatest success. Numbered among his customers were many of the largest and most active contractors, builders, and other users of compressed-air machinery in the city.

During this period he lived for a time in Plainfield, N. J., and later in New York. In 1922 he bought a farm at Toms River and retired there, spending the intervening years until his death with his family and friends and devoting much of his time each summer to the cultivation of vegetables and flowers.

Considering his abilities, Mr. Burgess undoubtedly could have made a fortune, had he so desired. But, like many who understand human nature, he was generous to a fault and distributed a goodly share of his earnings to his less fortunate acquaintances in the form of loans or outright gifts. Many who knew him believed that, under different conditions, he might have developed into another Mark Twain or Irvin S. Cobb, so pronounced was his capacity for comprehending human emotions.

Mr. Burgess is survived by his wife and one son, A. Lee Burgess, both of whom reside at Toms River.

It has been announced that all the principal trains of the United States railways will be partly or fully air conditioned by the end of 1934.

Drafting and drawing rooms and offices generally have been given two electrical aids in the form of an erasing machine and a pencil sharpener. The former is held like a pen, giving the operator complete control of the work of removing ink or pencil marks. The sharpener starts automatically as soon as a pencil is inserted, and stops when the point has been made. It can sharpen twenty pencils a minute.

Steam of Nature's making and issuing from the earth at The Geysers, Sonoma County, Calif., is to be put to practical use after years of planning. It is to be harnessed to turbines in a geothermal plant to be built there by the Geysers Development Company at an estimated cost of $250,000. The electric current generated is to be delivered to Healdsburg, fifteen miles distant, and to other neighboring communities over high-tension transmission lines.

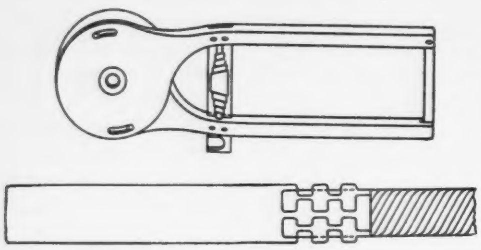
A machine has been developed by means of which the strength of proposed structures under or above ground can be determined with accuracy, according to the Engineering Foundation. In the centrifuge, as it is termed, is placed a model that is like the contemplated structure in every respect. This model is rotated at a calculated speed; and the machine, in which centrifugal force is substituted for the pull of gravity under actual conditions, indicates the relative strains and stresses to which the model is subjected. Machines of this type should prove of value in connection with foundation work and mining operations. One of them is in use in the mining laboratories of Columbia University.

A renewable or throw-away air filter has been introduced by the American Air Filter Company, Inc., Louisville, Ky. It is sold as the Type K unit, and consists of a filter cell and a permanent metal frame which is provided with clips for holding the filter in place and arranged so that adjacent frames can be bolted together to form an installation of any desired capacity. The filter cell is made of a continuous sheet of 6-ply material folded back and forth over corrugated spacers and securely encased in a heavy cardboard channel section. This construction makes it possible to obtain approximately 30 feet of filtering area in a single unit 20 inches square and 4 inches deep. Each unit is rated at 600 to 800 cfm., depending upon the amount of dust in the air. After a cell has accumulated its full load it is discarded for a clean one. The advantages claimed by the manufacturer for the new filter are high efficiency and low maintenance and first costs.

An announcement has been made by Ingersoll-Rand Company that it has doubled its line of 2-stage, air-cooled portable compressors. Six sizes are now available having capacities of 75, 125, 185, 250, 370, and 500 cfm., respectively. These are equipped for either oil-engine or gasoline-engine drive, whichever may be preferred. The oil engine, known as the "Type H", is a 4-cycle, solid-fuel-injection, spark-ignition engine that combines the best qualities of both forms of drive. It starts easily with a hand crank; operates smoothly with invisible exhaust; and has high torque at reduced speeds, thus giving it the "lugging" power of the steam engine. One great advantage of oil-engine drive is the saving in fuel cost resulting from the use of inexpensive, nonexplosive heavy oils such as are burned in household furnaces, etc. This class of portable compressors is described in Bulletin No. 2100, which may be obtained free of charge from Ingersoll-Rand Company's main office at 11 Broadway, New York City, or from any of its branch offices.

NEW TOOL FOR THE POWDERMAN'S KIT

IN PREPARING for a blast in a mine, a quarry, or on a construction job, it is necessary, among other things, to connect the blasting caps to the fuses that permit setting off the various charges from a safe distance. To the uninitiated this does not sound as though it would be a particularly difficult thing to do, and yet we are told that such connections, as generally made, are not what they should be.



From the early days, when the teeth were often used to press the cap down on the fuse, to the present machinelike wrap connections, none of the methods heretofore devised to do this work is capable of making a joint that meets all the service requirements, says a writer in *Glückauf*. Not infrequently the cap is split in squeezing it, or, with some tools, there is danger of bearing down on the explosive. But, even if the metal is not damaged while being subjected to pressure, the connection is apt to be loose and not watertight. The latter is the case when the cap is pressed into lengthwise folds which enable moisture to penetrate.

To overcome these handicaps there has been made what looks much like a pair of pincers. A line drawing of this tool, as well as of the type of joint made by it, is reproduced here. The pincers are the invention of J. Meissner, a civil engineer of Burbach, Germany. With them it is possible to press deep circumferential grooves into the metal cap and thus to clamp it so securely on to the fuse that even a strong pull will not break them apart. Besides leaving the metal unimpaired, the connection has the added advantage of being watertight so that, in case of misfire, the blasting cap can be removed from its hole with the fuse intact. Furthermore, the likelihood of any lateral escape of fire is precluded.

By reason of their small size, the pincers can be carried around conveniently; and they are so arranged that they can be adjusted to take blasting caps of different lengths. The new tool has been in use for some time in South Africa, and reports have it that it is giving excellent service there.

BENEFITS OF SMOKE ABATEMENT

THE "smoke farmers" of the Columbia Valley in Montana and in the proximity of the huge metallurgical plant of the Consolidated Mining & Smelting Company at Trail, across the border in Canada, have done a good service to the wheat farmers of Alberta in a roundabout way that is rather instructive. When the former entered suit against that company for damage done their crops by acid fumes issuing from the plant's smokestacks, it was induced to extract the fumes from the furnace gases and to put them to practical use in the production of sulphuric acid. While some of this chemical could be utilized about the smelters, a large quantity of it remained to be disposed of in some other way. The outcome was a fertilizer which is being marketed in Alberta and British Columbia.

One of the essential raw materials in the high-grade fertilizer now being made at Trail is phosphate rock, which is being imported. Some time ago the Consolidated Mining & Smelting Company sent geologists out in search of it in the Rocky Mountains. They found a lot of phosphate rock, particularly around Crowsnest Pass and Banff; and where it was richest and most abundant it was exposed by tunneling. It was too intimately mixed with useless rocky matter, however, to be of practical value, and so the company's metallurgists set about developing a commercially practicable process for its separation.

SPECIAL PNEUMATIC TUBE SYSTEM FOR TELEPHONE TOLL TICKETS

THE handling of toll tickets in busy telephone exchanges is an important phase of their operations and has reached a stage that can be called highly efficient only in late years through experimental work conducted by the Bell Telephone Company. A toll ticket, let it be said, is made out every time a long-distance call is put through, and constitutes a record for billing. On it is stamped the time the conversation is begun and its duration.

In the New York City toll office of the Bell Telephone Company, for example, where as many as 30,000 such calls may be received in a day, a pneumatic tube system is provided for the exclusive use of these tickets. Their transfer to the files, or intermediate points, and that of canceled, report, and call-order tickets, may involve upwards of 75,000 ticket-trips in 24 hours. To handle such a volume with dispatch, the usual carriers or containers are dispensed with, and the slips of paper are sent from the switchboard and elsewhere direct through ⅜x2¾-inch rectangular brass tubes to a distributing desk, whence they are similarly routed to their respective destinations.

But before a ticket is permitted to start on its journey it is given two flaps by folding back the ends—the air acting against them serving to increase the speed with which the ticket can be conveyed through the tube. Originally it was turned back at one end only; but it was found that the additional shorter rear flap made it possible, normally, to deliver it 10 per cent faster and, with a relative humidity of as much as 90 per cent, to reduce the number of delayed tickets by 50 per cent.

Travel is at the rate of about 30 feet per second. Even so, the force of the current of air is not sufficient to tear or to mutilate the paper, and the chance of loss in transit is nil. Moisture that causes tickets to stick and to jam the tubes, especially during humid weather, is largely overcome by the use of heaters placed at critical points; and bends and twists, that add to the difficulty, are eliminated wherever it is possible to do so.

Heretofore it was considered necessary to use an expensive paper for the tickets to assure their arrival at the filing desk in good condition. Now, as a result of the various improvements in the system, a low-grade paper serves the purpose. This reduction in cost of paper and of the system, itself, has put the latter within reach of many offices in less congested districts that still employ messengers to deliver the tickets or pass them along the switchboard from operator to operator.

PROTECTING PIPE AND POWER LINES IN OPEN-PIT WORKINGS

IT IS considered good practice to protect power cables and pipe lines in open-pit workings, especially where heavy blasts are set off to bring down the rock. A simple and effective method of doing this is used at the Flin Flon Mine of the Hudson Bay Mining & Smelting Company, says J. Cole, engineer for Canadian Explosives Limited, in *Concrete and Quarry*.

At that mine, the compressed-air and water pipes and the electric lines are run through two well-drill holes, each 6 inches in diameter, which are 20 feet back from the face and extend from the top of the working into a distributing chamber 100 feet below. This chamber is high enough to afford standing room, and in it, also out of harm's way, are the electric switches and the valves and pipe connections. A small tunnel leads to this chamber through a door—the tunnel portal also being closed by timbers resting loosely against the rock wall.

The protection thus given these vital arteries would certainly seem to justify the moderate expense involved, as damage to any one of them would, of necessity, interrupt operations until the particular line had been restored to service. The idea is not altogether a new one, as certain English collieries have for years safeguarded their haulage ropes in this fashion.